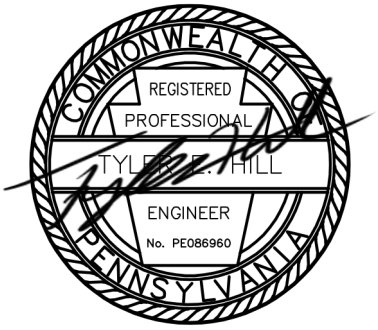
NPDES PCSM MODULE 2/
POST CONSTRUCTION
STORM WATER MANAGEMENT REPORT

FOR

THE WESTTOWN SCHOOL
OAK LANE PROJECT
WESTTOWN TOWNSHIP
CHESTER COUNTY, PA

PROJECT NO: 1091-001



January 27, 2023
Revised: September 19, 2023

This report is intended to provide supporting information and calculations associated with the approved PCSM Plans. Refer to the Approved Preliminary/Final Land Development Plan for Westtown School – Oak Lane Project, dated, January 27, 2023, last revised September 19, 2023

Prepared By:

ELA GROUP, INC.
743 S. Broad Street • Lititz, PA 17543
(717) 626-7271 • Fax (717) 626-7040
Website: www.elagroup.com • Email: staff@elagroup.com
Central PA Office • State College, PA

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
DISCHARGES OF STORMWATER ASSOCIATED WITH CONSTRUCTION ACTIVITIES
POST-CONSTRUCTION STORMWATER MANAGEMENT (PCSM) MODULE 2

Applicant: **The Westtown School**

Project Site Name: **The Westtown School - Oak Lane Projects**

Surface Water Name(s): **East Branch Chester Creek, Unt. to East Branch Chester Creek**

Surface Water Use(s): **TSF, MF**

PCSM PLAN INFORMATION

1. Identify all structural and non-structural PCSM BMPs that have been selected and provide the information requested.

Discharge Point(s)	BMP ID	BMP Name	BMP Manual	Latitude	Longitude	DA Treated (ac)
001	1	Infiltration Basin	6.4.2	39.944325	-75.539241	4.99
002	2	Subsurface Infiltration Bed	6.4.3	39.944787	-75.537636	2.22
002	3	Subsurface Infiltration Bed	6.4.3	39.945473	-75.537325	2.22
002	4	Infiltration Basin	6.4.2	39.946011	-75.535373	9.67

Undetained Areas: 4.86 acre(s)

☐ The Project Qualifies as a Site Restoration Project (25 Pa. Code §102.8(n))

2. Describe the sequence of PCSM BMP implementation in relation to earth disturbance activities and a schedule of inspections for the critical stages of PCSM BMP installation.

See plan sheet 4.

3. ☒ Plan drawings have been developed for the project and will be available on-site.

4. ☒ Plan drawings have been developed for the project and are attached to the NOI/application.

5. ☒ Recycling and proper disposal of materials associated with PCSM BMPs are addressed as part of long-term operation and maintenance of the PCSM BMPs.

6. Identify naturally occurring geologic formations or soil conditions that may have the potential to cause pollution after earth disturbance activities are completed and PCSM BMPs are operational and the applicant's plan to avoid or minimize potential pollution and its impacts.

   See plan sheet 4.

7. Identify whether the potential exists for thermal impacts to surface waters from post-construction stormwater. If such potential exists, identify BMPs that will be implemented to avoid, minimize, or mitigate potential thermal impacts.

   See plan sheet 4.

8. ☒ The PCSM Plan has been planned, designed, and will be implemented to be consistent with the E&S Plan.

9. ☒ A pre-development site characterization has been performed.

STORMWATER ANALYSIS – RUNOFF VOLUME

Surface Water Name: **East Branch Chester Creek** **Discharge Point(s):** **001**

1. ☐ The design standard is based on volume management requirements in an Act 167 Plan approved by DEP within the past five years.
2. ☒ The design standard is based on managing the net change for storms up to and including the 2-year/24-hour storm.
3. ☐ An alternative design standard is being used.
4. ☒ A printout of DEP's PCSM Spreadsheet – Volume Worksheet is attached.
5. 2-Year/24-Hour Storm Event: **3.26** inches Source of precipitation data: **NOAA Atlas 14**
6. Stormwater Runoff Volume, Pre-Construction Conditions: **8,282** CF ☒ Calculations attached
7. Stormwater Runoff Volume, Post-Construction Conditions: **18,798** CF ☒ Calculations attached
8. Net Change (Post-Construction – Pre-Construction Volumes): **10,516** CF
9. Identify all selected structural PCSM BMPs and provide the information requested. ☒ Calculations attached

DP No.	BMP ID	Series	Vol. Routed to BMP (CF)	Inf. Area (SF)	Inf. Rate (in/hr)	Inf. Period (hrs)	Veg?	Media Depth (ft)	Storage Vol. (CF)	Inf. Credit (CF)	ET Credit (CF)
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				

Total Infiltration & ET Credits (CF): **14,438**

Non-Structural BMP Volume Credits (CF) (Attach Calculations):

Managed Release Credits (CF) (Attach MRC Design Summary):

Volume Required to Reduce/Manage (CF): **10,516**

Total Credits (CF): **14,438**

INFILTRATION INFORMATION	
BMP ID: 1	☒ Soil/geologic test results are attached.
1. No. of infiltration tests completed: **3**	
2. Method(s) used for infiltration testing: **double ring infiltrometer**	
3. Test Pit Identifiers (from PCSM Plan Drawings): **14A, 14B, & 16A**	
4. Avg Infiltration Rate: **0.81** in/hr 5. FOS: **2** : 1	
6. Infiltration rate used for design: **0.41** in/hr	
7. Separation distance between the BMP bottom and bedrock: **>3.5'** feet	
8. Separation distance between the BMP bottom and seasonal high-water table: **>3.5'** feet	
9. Comments:	
BMP ID:	☐ Soil/geologic test results are attached.
1. No. of infiltration tests completed:	
2. Method(s) used for infiltration testing:	
3. Test Pit Identifiers (from PCSM Plan Drawings):	
4. Avg Infiltration Rate: in/hr 5. FOS: : 1	
6. Infiltration Rate Used for Design: in/hr	
7. Separation distance between the BMP bottom and bedrock: feet	
8. Separation distance between the BMP bottom and seasonal high-water table: feet	
9. Comments:	
BMP ID:	☐ Soil/geologic test results are attached.
1. No. of infiltration tests completed:	
2. Method(s) used for infiltration testing:	
3. Test Pit Identifiers (from PCSM Plan Drawings):	
4. Avg Infiltration Rate: in/hr 5. FOS: : 1	
6. Infiltration Rate Used for Design: in/hr	
7. Separation distance between the BMP bottom and bedrock: feet	
8. Separation distance between the BMP bottom and seasonal high-water table: feet	
9. Comments:	

STORMWATER ANALYSIS – RUNOFF VOLUME

Surface Water Name: **Unt. to East Branch Chester Creek** **Discharge Point(s):** **002**

1. ☐ The design standard is based on volume management requirements in an Act 167 Plan approved by DEP within the past five years.
2. ☒ The design standard is based on managing the net change for storms up to and including the 2-year/24-hour storm.
3. ☐ An alternative design standard is being used.
4. ☒ A printout of DEP's PCSM Spreadsheet – Volume Worksheet is attached.
5. 2-Year/24-Hour Storm Event: **3.26** inches Source of precipitation data: **NOAA Atlas 14**
6. Stormwater Runoff Volume, Pre-Construction Conditions: **20,730** CF ☒ Calculations attached
7. Stormwater Runoff Volume, Post-Construction Conditions: **70,265** CF ☒ Calculations attached
8. Net Change (Post-Construction – Pre-Construction Volumes): **49,535** CF
9. Identify all selected structural PCSM BMPs and provide the information requested. ☒ Calculations attached

DP No.	BMP ID	Series	Vol. Routed to BMP (CF)	Inf. Area (SF)	Inf. Rate (in/hr)	Inf. Period (hrs)	Veg?	Media Depth (ft)	Storage Vol. (CF)	Inf. Credit (CF)	ET Credit (CF)
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				
							☐				

Total Infiltration & ET Credits (CF): **63,695**

Non-Structural BMP Volume Credits (CF) (Attach Calculations):

Managed Release Credits (CF) (Attach MRC Design Summary):

Volume Required to Reduce/Manage (CF): **49,535**

Total Credits (CF): **63,695**

INFILTRATION INFORMATION	
BMP ID: 2	☒ Soil/geologic test results are attached.
1. No. of infiltration tests completed: **2**	
2. Method(s) used for infiltration testing: **double ring infiltrometer**	
3. Test Pit Identifiers (from PCSM Plan Drawings): **1A & 3B**	
4. Avg Infiltration Rate: **4.65** in/hr 5. FOS: **2** : 1	
6. Infiltration rate used for design: **2.32** in/hr	
7. Separation distance between the BMP bottom and bedrock: **>4'** feet	
8. Separation distance between the BMP bottom and seasonal high-water table: **>4'** feet	
9. Comments:	
BMP ID: 3	☒ Soil/geologic test results are attached.
1. No. of infiltration tests completed: **2**	
2. Method(s) used for infiltration testing: **double ring infiltrometer**	
3. Test Pit Identifiers (from PCSM Plan Drawings): **4A & 5A**	
4. Avg Infiltration Rate: **2.02** in/hr 5. FOS: **2** : 1	
6. Infiltration Rate Used for Design: **1.01** in/hr	
7. Separation distance between the BMP bottom and bedrock: **>4'** feet	
8. Separation distance between the BMP bottom and seasonal high-water table: **>4'** feet	
9. Comments:	
BMP ID: 4	☐ Soil/geologic test results are attached.
1. No. of infiltration tests completed: **2**	
2. Method(s) used for infiltration testing: **double ring infiltrometer**	
3. Test Pit Identifiers (from PCSM Plan Drawings): **6A & 7B**	
4. Avg Infiltration Rate: **1.67** in/hr 5. FOS: **2** : 1	
6. Infiltration Rate Used for Design: **0.84** in/hr	
7. Separation distance between the BMP bottom and bedrock: **>2'** feet	
8. Separation distance between the BMP bottom and seasonal high-water table: **2'** feet	
9. Comments:	

STORMWATER ANALYSIS – PEAK RATE

Surface Water Name: **East Branch Chester Creek** **Discharge Point(s):** **001**

1. ☐ The design standard is based on rate requirements in an Act 167 Plan approved by DEP within the past five years.
2. ☒ The design standard is based on managing the net change for 2-, 10-, 50-, and 100-year/24-hour storms.
3. ☐ An alternative design standard is being used.
4. ☐ A printout of DEP's PCSM Spreadsheet – Rate Worksheet is attached.
5. ☒ Alternative rate calculations are attached.
6. Identify precipitation amounts. Source of precipitation data:

2-Year/24-Hour Storm:	10-Year/24-Hour Storm
50-Year/24-Hour Storm:	100-Year/24-Hour Storm

7. Report peak discharge rates, pre- and post-construction (without BMPs), based on a time of concentration analysis.

Design Storm	Pre-Construction Peak Rate (cfs)	Post-Construction Peak Rate (cfs)	Difference (cfs)
2-Year/24-Hour			
10-Year/24-Hour			
50-Year/24-Hour			
100-Year/24-Hour			

8. Identify all BMPs used to mitigate peak rate differences and provide the requested information.

BMP ID	Inflow to BMP (cfs)				Outflow from BMP (cfs)			
	2-Yr	10-Yr	50-Yr	100-Yr	2-Yr	10-Yr	50-Yr	100-Yr

9. Report peak rates for pre-construction and post-construction with BMPs and identify the differences.

Design Storm	Pre-Construction Peak Rate (cfs)	Post-Construction Peak Rate (with BMPs) (cfs)	Difference (cfs)
2-Year/24-Hour	2.38	1.27	-1.11
10-Year/24-Hour	8.96	3.28	-5.68
50-Year/24-Hour	19.09	8.40	-10.69
100-Year/24-Hour	24.73	12.51	-12.22

STORMWATER ANALYSIS – PEAK RATE

Surface Water Name: **Unt. to East Branch Chester Creek** **Discharge Point(s):** **002**

1. ☐ The design standard is based on rate requirements in an Act 167 Plan approved by DEP within the past five years.
2. ☒ The design standard is based on managing the net change for 2-, 10-, 50-, and 100-year/24-hour storms.
3. ☐ An alternative design standard is being used.
4. ☐ A printout of DEP's PCSM Spreadsheet – Rate Worksheet is attached.
5. ☒ Alternative rate calculations are attached.
6. Identify precipitation amounts. Source of precipitation data:

2-Year/24-Hour Storm: 10-Year/24-Hour Storm

50-Year/24-Hour Storm: 100-Year/24-Hour Storm

7. Report peak discharge rates, pre- and post-construction (without BMPs), based on a time of concentration analysis.

Design Storm	Pre-Construction Peak Rate (cfs)	Post-Construction Peak Rate (cfs)	Difference (cfs)
2-Year/24-Hour			
10-Year/24-Hour			
50-Year/24-Hour			
100-Year/24-Hour			

8. Identify all BMPs used to mitigate peak rate differences and provide the requested information.

BMP ID	Inflow to BMP (cfs)				Outflow from BMP (cfs)			
	2-Yr	10-Yr	50-Yr	100-Yr	2-Yr	10-Yr	50-Yr	100-Yr

9. Report peak rates for pre-construction and post-construction with BMPs and identify the differences.

Design Storm	Pre-Construction Peak Rate (cfs)	Post-Construction Peak Rate (with BMPs) (cfs)	Difference (cfs)
2-Year/24-Hour	5.02	2.51	-2.51
10-Year/24-Hour	19.34	7.23	-12.11
50-Year/24-Hour	42.19	17.45	-24.74
100-Year/24-Hour	54.74	26.78	-27.96

STORMWATER ANALYSIS – WATER QUALITY

☒ A printout of DEP's PCSM Spreadsheet – Quality Worksheet is attached for all surface waters receiving discharges.

LONG-TERM O&M

Describe the long-term operation and maintenance (O&M) requirements for each selected PCSM BMP.

BMP ID	O&M Requirements
1	**See plan sheet 5**
2	**See plan sheet 5**
3	**See plan sheet 5**
4	**See plan sheet 5**

PCSM PLAN DEVELOPER

☒ I am trained and experienced in PCSM methods.

☒ I am a licensed professional.

Name:	**Tyler E. Hill, PE**	Title:	**Project Manager**
Company:	**ELA Group, Inc.**	Phone No.:	**717-626-7271**
Address:	**743 S. Broad St.**	Email:	**tehill@elagroup.com**
City, State, ZIP:	**Lititz, PA 17543**	License No.:	**PE086960**
License Type:	**Professional Engineer**	Exp. Date	**09/30/2023**

PCSM Plan Developer Signature

1/9/2023

Date

APPENDIX A
STORMWATER MANAGEMENT NARRATIVE

STORMWATER MANAGEMENT NARRATIVE

SITE DESCRIPTION

The project site is located near the center of the Westtown School campus, just south of Oak Lane. The existing site is largely comprised of existing grass athletic fields which are bordered to the north by a partially forested area and the school's academic centers; to the east by a baseball field and residential area; the south by agricultural fields (i.e. row crops) and a partially forested riparian area; and to the west by the school's working farm and agricultural area.

During the past 50 years, the site's primary use has been agricultural (i.e. row crops). The site is currently utilized primarily for athletic fields, with row crops along the southeastern portion of the project site. The site has been utilized as such for at least the past five years, with no significant improvements being constructed during that time.

SUMMARY OF PROPOSED IMPROVEMENTS

The Westtown School is proposing to improve upon the existing athletic facilities on campus by constructing two new synthetic turf multipurpose fields, along with reconfiguring the remaining area to maximize field space. Additional components of the project involve the construction of a support building, parking lot and improved pedestrian access.

SOIL DESCRIPTIONS, LIMITATIONS AND RESOULTIONS

As per the USDA NRCS Web Soil Survey, the soils within the project area (Limit of Disturbance) are classified as follows:

- CaB – Califon Loam (3-8% slopes, Hydrologic Soil Group "D")
- GgC – Glenelg Silt Loam (8-15% slopes, Hydrologic Soil Group "B")
- MaA – Manor Loam (0-3% slopes, Hydrologic Soil Group "B")
- MaB – Manor Loam (3-8% slopes, Hydrologic Soil Group "B")
- MaC – Manor Loam (8-15% slopes, Hydrologic Soil Group "B")

See the *Supplemental Design Information* section for a summary of the Soil Facts, Use Limitations and Resolutions.

GEOTECHNICAL ASSESSMENT

A geotechnical investigation was performed on site to evaluate the site for infiltration of post-construction stormwater. The investigation determined that the site is underlain by the politic schist of the Glenarm Wissahickon Formation. This formation includes lenticular amphibolite bodies having ocean-floor basalt chemistry and is not considered karst. Infiltration tests performed on site found suitable infiltration rates in nearly every test pit, but not at all depths. In general, the site was found to be well drained and suitable for infiltration.

The complete Stormwater Infiltration Feasibility Report, dated October 8, 2018, and Supplemental Infiltration Feasibility Report, dated November 9, 2018, has been provided as an attachment to this report.

NARRATIVE DESCRIPTION OF STORMWATER MANAGEMENT CONCEPT

The project site generally sits along a watershed drainage boundary and thus has been analyzed as two drainage areas. The south/western portion of the site generally drains to the southwest towards East Branch Chester Creek (TSF, MF). In post development there is one proposed discharge point (DP001) in this watershed. The eastern portion of the site drains to an existing riparian area consisting of wetlands, forested area and the headwaters of an unnamed tributary to East Branch Chester Creek. In post development, there is one proposed discharge point (DP002) in this watershed. See the Pre and Post Watershed Mapping in this report for watershed delineation.

In order to address rate control, volume control, and water quality requirements the following structural and non-structural BMPs are being proposed:

Infiltration Basin (BMP 1 & BMP 4)

- An infiltration basin is a constructed impoundment intended to capture and infiltrate stormwater runoff.
- Infiltration basin typically contains a layer of installed amended soils which typically contain a high percent of organic matter and additional large grained materials (such as sand) to provide an improved cation exchange rate and assure permeability.
- Infiltration basins are often planted with water-tolerant, native vegetation in order to increase water uptake via the vegetation's root system and increase pollutant removal.

Subsurface Infiltration Bed (BMP 2 and BMP 3)

- A subsurface detention bed is a void space, typically angular stone and/or manufactured chamber system, constructed beneath the surface on virgin material with the intent to capture and infiltrate stormwater runoff.
- Infiltration Beds BMP 2 and BMP 3 are to be installed beneath the synthetic turf fields and consist of crushed angular stone with perforated distribution pipes

BMP DESIGN NOTES

The proposed structural BMPs have been designed in general accordance with the PADEP Stormwater BMP Manual. Given the site topography and location of existing improvements, the design of Basin A required a slightly modified approach with minor deviations from the BMP Manual. First, as the only feasible location for infiltration within the East Branch Chester Creek watershed, impervious and overall loading ratios exceed the recommended values of 5:1 and 8:1, respectively. Loading ratios of approximately 7:1 and 28:1 are proposed. These loading ratios are acceptable as the contributing area does not present a high potential for pollution, the geology is not karst and thus sinkholes and groundwater contamination are not of concern, and the site is general well-drained.

Additionally, three (3) infiltration tests were performed within the infiltration footprint of BMP 1 at the infiltration invert elevation and yielded results of 0.0 in/hr, 1.0 in/hr, and 6.0 in/hr. Based on the results, and the general soil characteristics of the site the area is feasible for infiltration, however determination of a design infiltration rate is not straightforward due to the wide range and the presence of test with zero infiltration. As a result, the design infiltration rate has been determined by removing the highest and lowest recorded infiltration

rates and applying a safety factor of two (2) to the remaining infiltration rate. This approach is reasonable as the recorded infiltration rates in the other proposed infiltration facilities ranged from 1.00 in/hr to 6.00 in/hr, which suggests the site as a whole consists of relatively variable soils but is generally conducive for infiltration. The recorded rates of TP-14 and TP-16 of 1.00 in/hr and 6.00 in/hr are within the range of recorded values elsewhere onsite and thus utilizing the lower of the two would produce a conservative design rate. Additionally, notes have been added to the plan regarding the potentially unsuitable soils within BMP 1 which outline in-situ testing protocol to determine the extent of unsuitable soils and a remediation plan.

VOLUME MANAGEMENT SUMMARY

A geotechnical evaluation was performed by Advantage Engineers to determine the suitability of the site for infiltration practices. Based upon the analysis, the site is generally well-drained and suitable for infiltration. See the *Stormwater Infiltration Feasibility Report*, dated October 8, 2018 and the Supplemental Infiltration Feasibility Report, dated November 9, 2018, for more information and a complete list of infiltration test pit results.

The volume removal requirements have been analyzed separately for compliance with NPDES PAG-02 and the municipal requirements. NPDES PAG-02 requires that 20% of existing impervious area be considered meadow in good condition, whereas the Westtown Township Stormwater Management Ordinance (SWMO) requires that 40% of existing impervious area be considered meadow in good condition.

NPDES volume management calculations can be found in Appendix B – PADEP PCSM Spreadsheets and the volume management calculations for Westtown Township can be found in Appendix D – Supporting Volume Calculations.

A summary of the volume removal calculations considering NPDES and municipal requirements can be found for each watershed in the tables below.

East Branch Chester Creek

The increase in runoff for the 2-year/24-hour storm for East Branch Chester Creek is being fully mitigated within the Infiltration Basin (BMP 1). A summary of the volume calculatons can be seen in the following tables:

NPDES:

VOLUME SUMMARY
East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

JOB # : 1091-001
DATE: 1/13/2023
REVISED: 9/17/2023

Req'd Infiltration Volume	10,516 CF

STRUCTURAL BMPS

BMP ID	Infiltration Area (sf)	Impervious Area (sf)	Impervious LR	Overall Area (sf)	Overall LR	2 YR Runoff Volume (cf)	Storage Vol. (cf) @	Storage Elev.	Infiltration & ET Credit (CF)*
BMP 1	10,675	53,560	5.0:1	217,187	20:1	15,663	11,503	289.50	14,438
Total	10,675	53,560	5.0:1	217,187	20:1	15,663	11,503		**14,438**

*See Infiltration Volume Worksheets

Westtown Township:

VOLUME SUMMARY (Twp. Analysis)
East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

JOB # : 1091-001
DATE: 9/17/2023
REVISED:

Req'd Infiltration Volume	10,971 CF

STRUCTURAL BMPS

BMP ID	Infiltration Area (sf)	Impervious Area (sf)	Impervious LR	Overall Area (sf)	Overall LR	2 YR Runoff Volume (cf)	Storage Vol. (cf) @	Storage Elev.	Infiltration & ET Credit (CF)*
BMP 1	10,675	53,560	5.0:1	217,187	20:1	15,663	11,503	289.50	14,438
Total	10,675	53,560	5.0:1	217,187	20:1	15,663	11,503		**14,438**

*See Infiltration Volume Worksheets

Unt. to East Branch Chester Creek

The increase in volume for the 2-year/24-hour storm for the Unnamed Tributary to East Branch Chester Creek is being controlled through two (2) subsurface infiltration beds (BMP's 2&3) and an infiltration basin (BMP 4). A summary of the volume calculatons can be seen in the following tables:

NPDES:

VOLUME SUMMARY
UNT. TO EAST BRANCH CHESTER CREEK

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

JOB # : 1091-001
DATE: 1/13/2023
REVISED: 9/17/2023

Req'd Infiltration Volume (from WS 4)	49,535 CF

STRUCTURAL BMPS

BMP ID	Infiltration Area (sf)	Impervious		Overall		2 YR Runoff Volume (cf)	Storage		Volume Credits (cf)*
		Area (sf)	LR	Area (sf)	LR		Vol. (cf) @	Elev.	
2	75,725	96,824	1.3:1	96,824	1.3:1	24,426	23,035	316.75	24,426
3	26,795	96,824	3.6:1	96,824	3.6:1	24,426	21,916	321.00	24,357
4	19,809	12,972	0.7:1	421,241	21.3:1	14,912	22,478	311.00	14,912
Total	122,329	206,620	1.7:1	614,889	5:1	63,764	67,429		**63,695**

*See Infiltration Volume Worksheets

Westtown Township:

VOLUME SUMMARY
UNT. TO EAST BRANCH CHESTER CREEK

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

JOB # : 1091-001
DATE: 1/13/2023
REVISED:

Req'd Infiltration Volume (from WS 4)	49,557 CF

STRUCTURAL BMPS

BMP ID	Infiltration Area (sf)	Impervious		Overall		2 YR Runoff Volume (cf)	Storage		Infiltration Volume *
		Area (sf)	LR	Area (sf)	LR		Vol. (cf) @	Elev.	
2	75,725	96,824	1.3:1	96,824	1.3:1	24,426	23,035	316.75	24,426
3	26,795	96,824	3.6:1	96,824	3.6:1	24,426	21,916	321.00	24,357
4	19,809	12,972	0.7:1	421,241	21.3:1	14,912	22,478	311.00	14,912
Total	122,329	206,620	1.7:1	614,889	5:1	63,764	67,429		**63,695**

*See Infiltration Volume Worksheets

See Appendix B for complete volume calculations.

PEAK RATE SUMMARY CALCULATIONS

The peak rate calculations have been provided to show compliance with the Westtown Township SWMO as well as NPDES PAG-02 requirements. The Township requires that all non-impervious areas be treated as meadow and 40% of impervious areas be treated as meadow in pre-development conditions. Since this requirement is more stringent than NDPES requirements it has been used as the standard for peak rate calculations.

Additionally, the Township requires a 50% reduction in onsite peak flows from pre- to post-development.

The following tables summarize the calculations for the pre-development peak flows, allowable post-development outflows, and the calculated outflow from each BMP and subdrainage area. Post development flows assume hydraulic routing through the proposed detention/infiltration facilities. All flows are in cfs. See Appendix E within this report for complete area calculations and hydrographs.

SUMMARY OF FLOWS - NRCS Rainfall-Runoff

East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester
JOB # : 1091-001
DATE: 1/13/2023
REVISED: 9/17/2023

WATERSHEDS	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
PRE-DEVELOPMENT	Flows (cfs)					
Pre-Dev. (E. Branch Chester Creek(EBCC))	2.38	5.68	8.96	14.25	19.09	24.73
Total Pre-Development						
EBCC Onsite (Reduction Factor)	1.53	3.84	6.21	10.05	13.58	17.68
50% Reduction	0.76	1.92	3.11	5.03	6.79	8.84
Allowable Post-Development Flow (Pre-Dev. - 50% Reduction)	1.62	3.76	5.86	9.23	12.30	15.89
POST-DEVELOPMENT						
EBCC-Undetained	1.27	2.31	3.28	4.79	6.12	7.62
BMP 1	0.16	0.62	1.63	4.43	7.56	11.46
Total Post-Development(Combined Hydrographs)	**1.27**	**2.31**	**3.28**	**5.06**	**8.40**	**12.51**

SUMMARY OF FLOWS - NRCS Rainfall-Runoff

Unt. to East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester
JOB # : 1091-001
DATE: 1/13/2023
REVISED: 9/17/2023

WATERSHEDS	2 yr	5 yr	10 yr	25 yr	50 yr	100 yr
PRE-DEVELOPMENT	Flows (cfs)					
Pre-Dev. UNT. to East Branch Chester Creek (EBCC)	5.02	12.03	19.34	31.25	42.19	54.74
Total Pre-Development						
Unt. to EBCC Onsite (Reduction Factor)	3.66	8.78	14.12	22.81	30.80	39.96
50% Reduction	1.83	4.39	7.06	11.41	15.40	19.98
Allowable Post-Development Flow	3.19	7.64	12.28	19.85	26.79	34.76
POST-DEVELOPMENT						
BMP 3	0.01	0.08	0.12	0.17	0.22	0.44
BMP 2	0.00	0.15	0.32	0.76	1.33	2.11
BMP 4	0.02	0.75	2.04	7.99	15.12	23.74
Unt. to EBCC Undetained	2.51	4.94	7.23	10.84	14.08	17.79
Total Post-Development(Combined Hydrographs)	**2.51**	**4.94**	**7.23**	**10.84**	**17.45**	**26.78**

OFFSITE DISCHARGE ANALYSIS

DP001

Discharge Point (DP)001 is considered to be the proposed outfall of BMP 1. In order to reduce the risk of downstream erosion a rip-rap apron will be imployed to dissipate the energy and spread out the concentrated discharge of the endwall. The rip-rap has been designed using current design standards based on pipe size, outflow and anticipated velocity. Approximately 100 feet downslope of the discharge point the outflow enters and existing roadside swale. The flowpath between the discharge path and drainage swale is a well vegetated open area. The relatively short flowpath should reduce the amount of re-concentration of runoff. After the runoff enters the swale it continues on to an existing culvert which discharges to another reach of swale that enters the receiving surface water (refer to the Overall Drainage Map, sheet 44 of 44). Since the post-development rate and volume of runoff from the project site tributary to the existing drainage swale is being reduced from pre- to post development there is no risk of accelerated erosion to the downstream flowpath of runoff leaving the site at DP001. Further, mitigation is being provided in the form of a rip-rap apron to prevent erosion prior to runoff entering the existing drainage swale.

DP002

Discharge Point (DP)002 is considered to be the proposed outfall of BMP 4. DP002 discharges to an existing, well vegetated natural draw. This natural draw becomes the headwaters of the receiving watercourse approximately 350’ downslope of DP002. In order to reduce the risk of downstream erosion a rip-rap apron will be imployed to dissipate the energy and spread out the concentrated discharge of the endwall. The rip-rap has been designed using current design standards based on pipe size, outflow and anticipated velocity. Given the mild slope of the draw, quality and density of the vegetation, and the proposed outlet protection (rip-rap) there is no anticipated risk of accelerated erosion to the downstream flowpath.

APPENDIX B
PADEP PCSM SPREADSHEETS

APPENDIX B
PADEP PCSM SPREADSHEETS
(EAST BRANCH CHESTER CREEK)

General Information

Instructions | *General* | Volume | Rate | Quality

Project Name:	**The Westtown School - Oak Lane Project**	Application Type:	**PAG-02 NOI**
County:	**Chester**	Municipality:	**Westtown Township**
Project Type:	**Other**	◉ New Project	○ Minor / Major Amendment
Area: *(In Watershed)*	**6.60** acres	Total Earth Disturbance: *(In Watershed)*	**4.91** acres
No. of Post-Construction Discharge Points:	**1**	Start DP Numbering at:	**001**

Discharge Point (DP) No.	Drainage Area (DA) (acres)	Earth Disturbance in DA (acres)	Existing Impervious in DA (acres)	Proposed Impervious in DA (acres)	Receiving Waters	Ch. 93 Class	Structural BMP(s)
001	4.99	3.36	0.34	1.23	Discharge to MS4	TSF, MF	Yes
Undetained Areas	1.27	1.21	0.08	0.15	Discharge to MS4	TSF, MF	
Totals:	**6.26**	**4.57**	**0.42**	**1.38**			

Volume Management

Project: The Westtown School - Oak Lane Project

Instructions | General | *Volume* | Rate | Quality

2-Year / 24-Hour Storm Event (NOAA Atlas 14): **3.26** inches

Alternative 2-Year / 24-Hour Storm Event: inches

Alternative Source:

Pre-Construction Conditions: *No. Rows:* **3** ☐ *Exempt from Meadow in Good Condition* ☑ *Automatically Calculate CN, Ia, Runoff and Volume*

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	0.19	B	98	0.041	3.03	2,066
Pervious as Meadow	4.68	B	58	1.448	0.36	6,154
Impervious as Meadow	0.05	B	58	1.448	0.36	62
TOTAL (ACRES):	**4.91**				**TOTAL (CF):**	**8,282**

Post-Construction Conditions: *No. Rows:* **2**

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	1.19	B	98	0.041	3.03	13,033
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	3.39	B	61	1.279	0.47	5,765
TOTAL (ACRES):	**4.57**				**TOTAL (CF):**	**18,798**

NET CHANGE IN VOLUME TO MANAGE (CF): **10,516**

Non-Structural BMP Volume Credits:

☐ Tree Planting Credit

☐ Other (attach calculations):

Structural BMP Volume Credits: *No. Structural BMPs:* **1** *Start BMP Numbering at:* **1**

DP No.	BMP No.	BMP Name	MRC?	Discharge	Incremental BMP DA (acres)	Volume Routed to BMP (CF)	Infiltration / Vegetated Area (SF)	Infiltration Rate (in/hr)	Infiltration Period (hrs)	Vegeta-ted?	Media Depth (ft)	Storage Volume (CF)	Infiltration Credit (CF)	ET Credit (CF)
001	1	Infiltration Basin		Off-Site	3.36	15,663	10,675	0.41	34	Yes	1.0	11,503	**11,161**	**3,277**
												Totals:	**11,161**	**3,277**

INFILTRATION & ET CREDITS (CF): **14,438**

NET CHANGE IN VOLUME TO MANAGE (CF): **10,516**

TOTAL CREDITS (CF): **14,438**

VOLUME REQUIREMENT SATISFIED

Rate Control

Project: The Westtown School - Oak Lane Project

Instructions | General | Volume | *Rate* | Quality

Precipitation Amounts:

NOAA 2-Year 24-Hour Storm Event (in):	**3.26**	Alternative 2-Year 24-Hour Storm Event (in):	
NOAA 10-Year 24-Hour Storm Event (in):	**4.8**	Alternative 10-Year 24-Hour Storm Event (in):	
NOAA 50-Year 24-Hour Storm Event (in):	**6.66**	Alternative 50-Year 24-Hour Storm Event (in):	
NOAA 100-Year 24-Hour Storm Event (in):	**7.58**	Alternative 100-Year 24-Hour Storm Event (in):	

☑ **Report Summary of Peak Rates Only**

Attach model input and output data or other calculations to support the rates reported below.

	Peak Discharge Rates (cfs)			
	Pre-Construction	**Post-Construction**	**Net Change**	
2-Year Storm:	**2.38**	**1.27**	**-1.11**	***Rate Control Satisfied***
10-Year Storm:	**8.96**	**3.28**	**-5.68**	***Rate Control Satisfied***
50-Year Storm:	**19.09**	**8.40**	**-10.69**	***Rate Control Satisfied***
100-Year Storm:	**24.73**	**12.51**	**-12.22**	***Rate Control Satisfied***

Water Quality

Project: The Westtown School - Oak Lane Project

PRINT

Instructions | General | Volume | Rate | *Quality*

Pre-Construction Pollutant Loads:

Land Cover (from Volume Worksheet)	Land Cover for Water Quality	Area (acres)	Soil Group	Runoff Volume (cf)	Pollutant Conc. (mg/L)			Pollutant Loads (lbs)		
					TSS	TP	TN	TSS	TP	TN
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	Residential	0.19	B	2,066	65.0	0.29	2.05	8.39	0.04	0.26
Pervious as Meadow	Grassland/Herbaceous	4.68	B	6,154	48.8	0.22	2.30	18.75	0.08	0.88
Impervious as Meadow	Grassland/Herbaceous	0.05	B	62	48.8	0.22	2.30	0.19	0.00	0.01
	TOTAL (ACRES):	**4.91**					**TOTALS:**	**27.33**	**0.12**	**1.16**

Post-Construction Pollutant Loads (without BMPs):

Land Cover (from Volume Worksheet)	Land Cover for Water Quality	Area (acres)	Soil Group	Runoff Volume (cf)	Pollutant Conc. (mg/L)			Pollutant Loads (lbs)		
					TSS	TP	TN	TSS	TP	TN
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	Residential	1.19	B	13,033	65.0	0.29	2.05	52.90	0.24	1.67
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	Open Space	3.39	B	5,765	78.0	0.25	1.25	28.08	0.09	0.45

TOTAL (ACRES):	**4.57**	**TOTALS:**	**80.98**	**0.33**	**2.12**

POLLUTANT LOAD REDUCTION REQUIREMENTS (LBS):	**53.65**	**0.20**	**0.96**

☐ **Characterize Undetained Areas (for Untreated Stormwater)**

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)

Non-Structural BMP Water Quality Credits:

☐ Pervious Undetained Area Credit

☐ Other (attach calculations)

Structural BMP Water Quality Credits:

☑ *Use default BMP Outflows and Median BMP Outflow Concentrations*

DP No.	BMP No.	BMP Name	MRC?	BMP DA (acres)	Vol. Routed to BMP (CF)	Inf. & ET Credits (CF)	Capture & Buffer Credits (CF)	Outflow (CF)	Outflow Conc. (mg/L)			Pollutant Loads (lbs)		
									TSS	TP	TN	TSS	TP	TN
001	1	Infiltration Basin		3.36	15,663	14,438		1,225	10.00	0.24	0.96	0.76	0.02	0.07

	TSS	TP	TN
POLLUTANT LOADS FROM STRUCTURAL BMP (TREATED) OUTFLOWS (LBS):	**0.76**	**0.02**	**0.07**
POLLUTANT LOADS FROM UNTREATED STORMWATER (LBS):	**13.50**	**0.05**	**0.35**
NON-STRUCTURAL BMP WATER QUALITY CREDITS (LBS):			
NET POLLUTANT LOADS FROM SITE, POST-CONSTRUCTION (LBS):	**14.27**	**0.07**	**0.43**
POLLUTANT LOADS FROM SITE, PRE-CONSTRUCTION (LBS):	**27.33**	**0.12**	**1.16**

WATER QUALITY REQUIREMENT SATISFIED

CERTIFICATION

I certify under penalty of law and subject to the penalties of 18 Pa.C.S. § 4904 (relating to unsworn falsification to authorities) that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I further certify that the structure, function, and calculations contained in this spreadsheet have not been modified in comparison to the spreadsheet DEP has posted to its website or, if modifications were made, an explanation of the modifications made is attached to this spreadsheet.

Tyler E. Hill, PE	9/17/2023
Spreadsheet User Name	Date

UNT. TO
EAST BRANCH CHESTER CREEK

General Information

Instructions | *General* | Volume | Rate | Quality

Project Name: **The Westtown School - Oak Lane Project**

Application Type: **PAG-02 NOI**

County: **Chester**

Municipality: **Westtown Township**

Project Type: **Other**

◉ New Project ○ Minor / Major Amendment

Area: **17.70** acres
(In Watershed)

Total Earth Disturbance: **13.02** acres
(In Watershed)

No. of Post-Construction Discharge Points: **1**

Start DP Numbering at: **002**

Discharge Point (DP) No.	Drainage Area (DA) (acres)	Earth Disturbance in DA (acres)	Existing Impervious in DA (acres)	Proposed Impervious in DA (acres)	Receiving Waters	Ch. 93 Class	Structural BMP(s)
002	14.11	10.41	0.01	4.74	Unt. to E. Branch Chester Creek	TSF, MF	Yes
Undetained Areas	3.59	2.61	0.01	0.00	Unt. to E. Branch Chester Creek	TSF, MF	
Totals:	**17.70**	**13.02**	**0.02**	**4.74**			

Volume Management

Project: The Westtown School - Oak Lane Project

Instructions | General | *Volume* | Rate | Quality

2-Year / 24-Hour Storm Event (NOAA Atlas 14): **3.26** inches

Alternative 2-Year / 24-Hour Storm Event [ ] inches

Alternative Source: [ ]

Pre-Construction Conditions: *No. Rows:* **4**

☐ *Exempt from Meadow in Good Condition* ☑ *Automatically Calculate CN, Ia, Runoff and Volume*

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	0.01	B	98	0.041	3.03	88
Pervious as Meadow	11.53	B	58	1.448	0.36	15,168
Impervious as Meadow	0.00	B	58	1.448	0.36	3
Pervious as Meadow	1.14	D	78	0.564	1.32	5,471
TOTAL (ACRES):	**12.68**				**TOTAL (CF):**	**20,730**

Post-Construction Conditions: *No. Rows:* **3**

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	4.74	B	98	0.041	3.03	52,121
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	7.13	B	61	1.279	0.47	12,130
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	1.14	D	80	0.500	1.45	6,014
TOTAL (ACRES):	**13.02**				**TOTAL (CF):**	**70,265**

NET CHANGE IN VOLUME TO MANAGE (CF):	49,535

Non-Structural BMP Volume Credits:

☐ Tree Planting Credit

☐ Other (attach calculations):

Structural BMP Volume Credits: *No. Structural BMPs:* **3** *Start BMP Numbering at:* **2**

DP No.	BMP No.	BMP Name	MRC?	Discharge	Incremental BMP DA (acres)	Volume Routed to BMP (CF)	Infiltration / Vegetated Area (SF)	Infiltration Rate (in/hr)	Infiltration Period (hrs)	Vegeta-ted?	Media Depth (ft)	Storage Volume (CF)	Infiltration Credit (CF)	ET Credit (CF)
002	2	Infiltration Bed		to BMP No. 4	2.22	24,426	75,725	2.32	12	No		23,035	**24,426**	
002	3	Infiltration Bed		to BMP No. 4	2.22	24,426	26,795	1.01	12	No		21,916	**24,357**	
002	4	Infiltration Basin		Off-Site	9.67	14,912	19,809	0.84	16	Yes	1.0	14,912	**14,912**	**0**
												Totals:	**63,695**	

INFILTRATION & ET CREDITS (CF):	63,695
NET CHANGE IN VOLUME TO MANAGE (CF):	49,535
TOTAL CREDITS (CF):	63,695

VOLUME REQUIREMENT SATISFIED

Rate Control

Project: The Westtown School - Oak Lane Project

Instructions | General | Volume | *Rate* | Quality

Precipitation Amounts:

NOAA 2-Year 24-Hour Storm Event (in):	**3.26**	Alternative 2-Year 24-Hour Storm Event (in):	
NOAA 10-Year 24-Hour Storm Event (in):	**4.8**	Alternative 10-Year 24-Hour Storm Event (in):	
NOAA 50-Year 24-Hour Storm Event (in):	**6.66**	Alternative 50-Year 24-Hour Storm Event (in):	
NOAA 100-Year 24-Hour Storm Event (in):	**7.58**	Alternative 100-Year 24-Hour Storm Event (in):	

☑ **Report Summary of Peak Rates Only**

Attach model input and output data or other calculations to support the rates reported below.

	Peak Discharge Rates (cfs)			
	Pre-Construction	**Post-Construction**	**Net Change**	
2-Year Storm:	**5.02**	**2.51**	**-2.51**	***Rate Control Satisfied***
10-Year Storm:	**19.34**	**7.23**	**-12.11**	***Rate Control Satisfied***
50-Year Storm:	**42.19**	**17.45**	**-24.74**	***Rate Control Satisfied***
100-Year Storm:	**54.74**	**26.78**	**-27.96**	***Rate Control Satisfied***

Water Quality

Project: The Westtown School - Oak Lane Project

PRINT

Instructions | General | Volume | Rate | *Quality*

Pre-Construction Pollutant Loads:

Land Cover (from Volume Worksheet)	Land Cover for Water Quality	Area (acres)	Soil Group	Runoff Volume (cf)	Pollutant Conc. (mg/L)			Pollutant Loads (lbs)		
					TSS	TP	TN	TSS	TP	TN
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	Residential	0.01	B	88	65.0	0.29	2.05	0.36	0.00	0.01
Pervious as Meadow	Grassland/Herbaceous	11.53	B	15,168	48.8	0.22	2.30	46.22	0.21	2.18
Impervious as Meadow	Grassland/Herbaceous	0.00	B	3	48.8	0.22	2.30	0.01	0.00	0.00
Pervious as Meadow	Grassland/Herbaceous	1.14	D	5,471	48.8	0.22	2.30	16.67	0.08	0.79
	TOTAL (ACRES):	**12.68**					**TOTALS:**	**63.26**	**0.29**	**2.98**

Post-Construction Pollutant Loads (without BMPs):

Land Cover (from Volume Worksheet)	Land Cover for Water Quality	Area (acres)	Soil Group	Runoff Volume (cf)	Pollutant Conc. (mg/L)			Pollutant Loads (lbs)		
					TSS	TP	TN	TSS	TP	TN
Impervious Areas: Paved Parking Lots, Roofs, Driveways, Etc. (Excluding ROW)	Residential	4.74	B	52,121	65.0	0.29	2.05	211.55	0.94	6.67

Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	Open Space	7.13	B	12,130	78.0	0.25	1.25	59.08	0.19	0.95
Open Space (Lawns, Parks, Golf Courses, Cemeteries, Etc.) - Good Condition (Grass Cover > 75%)	Open Space	1.14	D	6,014	78.0	0.25	1.25	29.29	0.09	0.47
	TOTAL (ACRES):	**13.02**					**TOTALS:**	**299.92**	**1.23**	**8.09**

POLLUTANT LOAD REDUCTION REQUIREMENTS (LBS): **236.66** **0.94** **5.11**

☐ **Characterize Undetained Areas (for Untreated Stormwater)**

Land Cover	Area (acres)	Soil Group	CN	Ia (in)	Q Runoff (in)	Runoff Volume (cf)

Non-Structural BMP Water Quality Credits:

☐ Pervious Undetained Area Credit

☐ Other (attach calculations)

Structural BMP Water Quality Credits:

☑ *Use default BMP Outflows and Median BMP Outflow Concentrations*

DP No.	BMP No.	BMP Name	MRC?	BMP DA (acres)	Vol. Routed to BMP (CF)	Inf. & ET Credits (CF)	Capture & Buffer Credits (CF)	Outflow (CF)	Outflow Conc. (mg/L)			Pollutant Loads (lbs)		
									TSS	TP	TN	TSS	TP	TN
002	2	Infiltration Bed		2.22	24,426	24,426		0	-	-	-	-	-	-
002	3	Infiltration Bed		2.22	24,426	24,357		69	-	-	-	-	-	-
002	4	Infiltration Basin		9.74	14,912	14,912		0	10.00	0.24	0.96	0.00	0.00	0.00

	TSS	TP	TN
POLLUTANT LOADS FROM STRUCTURAL BMP (TREATED) OUTFLOWS (LBS):	0.00	0.00	0.00
POLLUTANT LOADS FROM UNTREATED STORMWATER (LBS):	28.04	0.11	0.76
NON-STRUCTURAL BMP WATER QUALITY CREDITS (LBS):			
NET POLLUTANT LOADS FROM SITE, POST-CONSTRUCTION (LBS):	28.04	0.11	0.76
POLLUTANT LOADS FROM SITE, PRE-CONSTRUCTION (LBS):	63.26	0.29	2.98

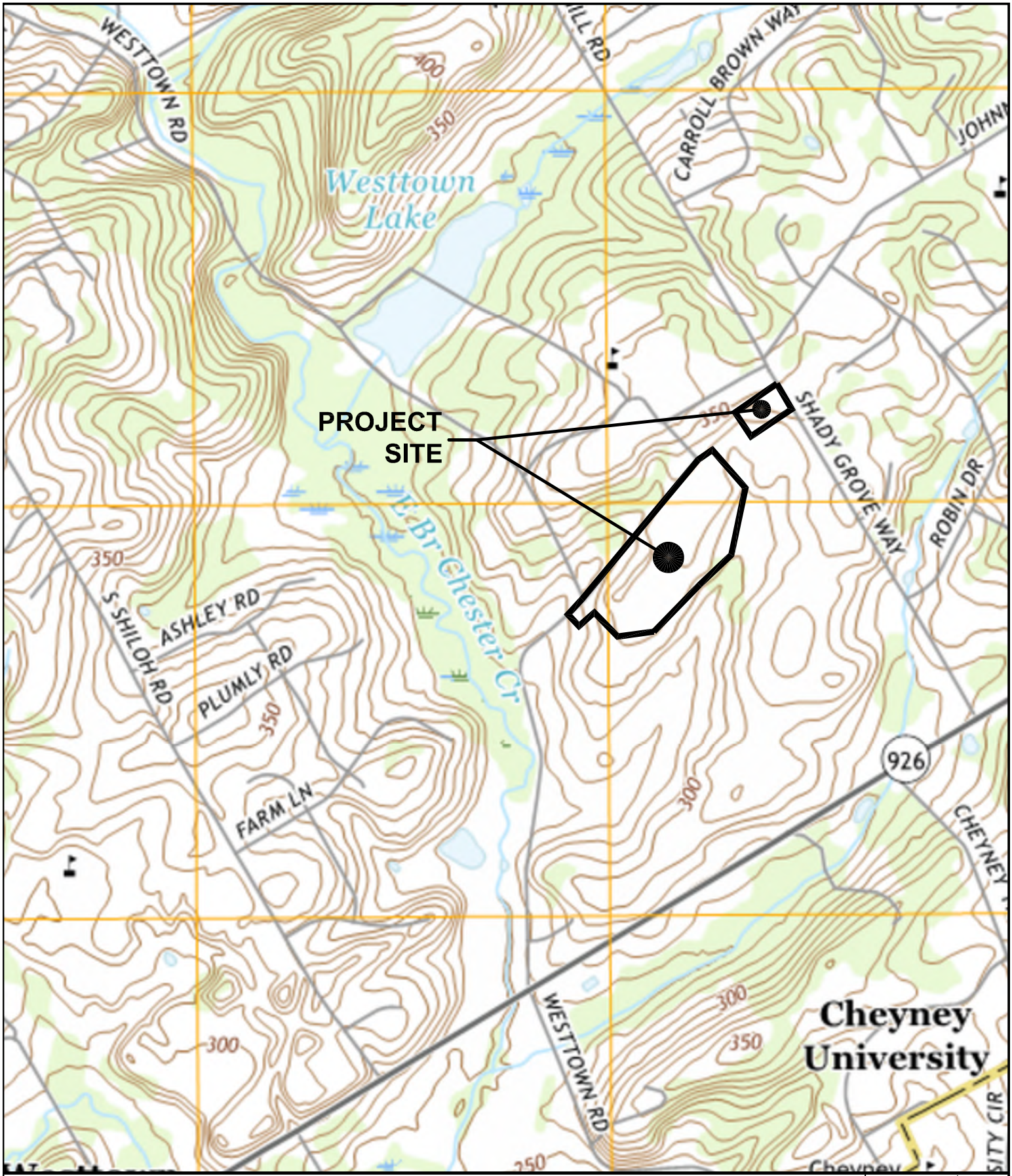
WATER QUALITY REQUIREMENT SATISFIED

CERTIFICATION

I certify under penalty of law and subject to the penalties of 18 Pa.C.S. § 4904 (relating to unsworn falsification to authorities) that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I further certify that the structure, function, and calculations contained in this spreadsheet have not been modified in comparison to the spreadsheet DEP has posted to its website or, if modifications were made, an explanation of the modifications made is attached to this spreadsheet.

Tyler E. Hill, PE	9/17/2023
Spreadsheet User Name	Date

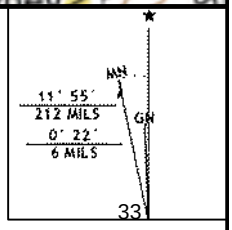
APPENDIX C
REFERENCE & SUPPORTING DOCUMENTS



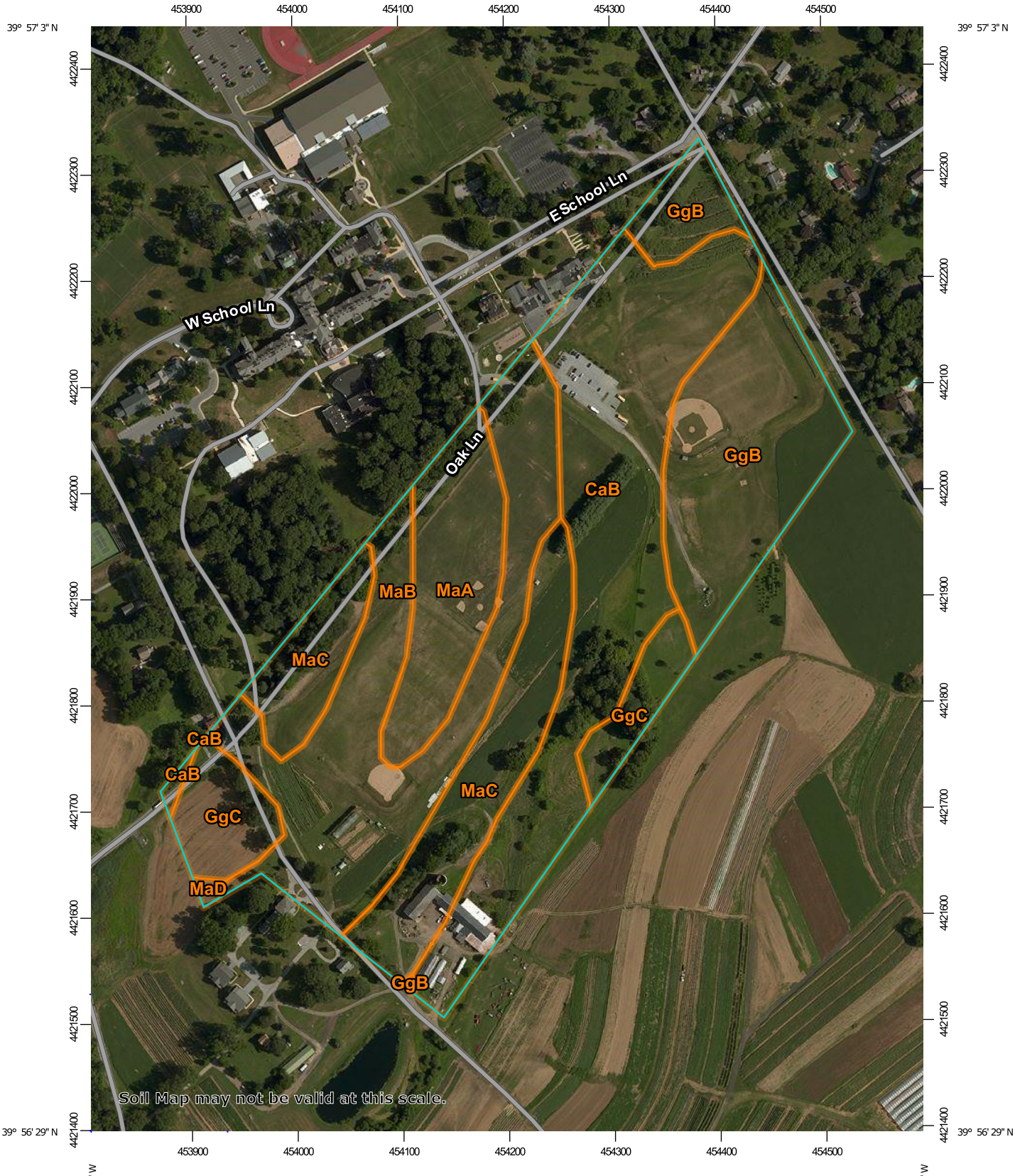
USGS 7.5 MINUTE
WEST CHESTER, PA QUADRANGLE

SCALE IN FEET: 1" = 1000

1:1 500 1000 2000 3000



Soil Map



Map Scale: 1:5,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CaB	Califon loam, 3 to 8 percent slopes	16.5	28.4%
GgB	Glenelg silt loam, 3 to 8 percent slopes	10.4	17.9%
GgC	Glenelg silt loam, 8 to 15 percent slopes	4.0	6.9%
MaA	Manor loam, 0 to 3 percent slopes	5.5	9.4%
MaB	Manor loam, 3 to 8 percent slopes	12.9	22.2%
MaC	Manor loam, 8 to 15 percent slopes	8.7	15.0%
MaD	Manor loam, 15 to 25 percent slopes	0.1	0.2%
Totals for Area of Interest		**58.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit

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SOILS INFORMATION FACT SHEET

SOIL						SUITABILITY				SOIL CONDITIONS FOR CONSTRUCTION			
SYMBOL NAME	TEXTURE	SLOPE, %	HYDRO. SOIL GROUP	HYDRIC (INCLUSIONS)	ERODIBILITY (K)	DEPTH OF WATER TABLE (IN)	DEPTH TO BEDROCK (IN)	WINTER GRADING	FROST ACTION	SURFACE WATER MANAGEMENT	BUILDING SITE	ROADFILL	TOPSOIL
CaB Califon	Loam	3 to 8	D		0.32	6 to 36	72 to 99	Limited	High	Somewhat Limited	Very Limited	Fair	Fair
GgC Glenelg	Silt Loam	8 to 15	B		0.37	80+	80+	Somewhat Limited	Moderate	Very Limited	Very Limited	Fair	Fair
MaA Manor	Loam	0 to 3	B		0.28	80+	72 to 99	Somewhat Limited	Moderate	Not Limited	Somewhat Limited	Poor	Fair
MaB Manor	Loam	3 to 8	B		0.28	80+	72 to 99	Somewhat Limited	Moderate	Very Limited	Somewhat Limited	Poor	Fair
MaC Manor	Loam	8 to 15	B		0.28	80+	59 to 100	Somewhat Limited	Moderate	Very Limited	Very Limited	Poor	Poor

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Date: 10/25/2018

SOIL LIMITATIONS & RESOLUTIONS

SOIL	LIMITATIONS		CHARACTERISTICS	RESOLUTIONS	COMMENTS
CaB GgC MaA MaB Mac	Cutbanks Cave	Excavations	The walls of excavations tend to cave in or slough	It is imperative that appropriate precautions be taken to safeguard workers during all trenching and excavation operations.	All applicable OSHA standards and regulations must be implemented at all times.
CaB (C/S) GgC (C) MaA (C) MaB (C) MaC (C)	Corrosive to Concrete/ Steel	Foundation and other infrastructural materials that may contact the soil	Weakening or dissolution of concrete or uncoated steel caused by soil-induced electrochemical or chemical action.	Suitable precautions should be taken to protect all underground pipes, conduits, and storage tanks from concrete and steel corrosion. If potential corrosive properties are encountered during construction, impacted utilities in that area shall be backfilled with processed aggregate to reduce the potential of corrosion from soil backfill.	Refer to the Geotechnical Report
GgC MaA MaB MaC	Erodibility	Grassed Waterways Terraces Slopes Stabilization Landscaping	Easily Erodible Rill and/or Gully Erosion	Excavation should occur during low-rainfall periods when possible Minimize duration of earth disturbance Immediately stabilize with erosion control matting, mulch, or sod. Avoid concentrating runoff in disturbed areas	See Erosion and Sediment Control Plan
CaB	Depth to Saturated Zone/ Seasonal High Water Table	Buildings w/ basements Excavations Stormwater Facilities	High table Wetness Soil mottling	Suitable precautions should be taken if water is encountered Contractor is to utilize pumping techniques and other methods as recommended by a Geotechnical Engineer.	Contact Geotechnical Engineer if shallow groundwater is encountered
CaB GgC MaA MaB Mac	Frost Action	Winter Grading	Frost heaving or upward swelling of soil during freezing conditons.	Do not grade, fill, or backfill during periods of freezing temperatures. Proper precautions should be taken to prevent damage, especially to roadways.	
GgC	Hydric/ Hydric Inclusions	[illegible] unless authorized by DEP and/or ACOE if wetlands present	Wetlands Wetness	Delineate and Protect Wetlands Obtain all permits/authorizations Utilize pumping techniques where appropriate	See wetland delineation repot
CaB GgC MaA MaB MaC	Low Strength/ Landslide Prone	Steep Slopes Structural Fill	Low strength soils are prone failure on steep slopes.	Precautions should be taken to prevent slope failures due to improper construction practices such as over-steepening and overloading of slopes, removal of lateral support, and failure to prevent saturation of slopes. Setbacks should comply with the standards contained in Chapter 16 unless it can be shown that proposed cuts and fills do not pose a hazard to public safety or to surface waters. Road fill/other structural fill material will likely need to be imported in areas where soils have low strength.	See geotechnical engineering report or consult the geotechnical professional on record
CaB GgC MaA MaB MaC	Slow Percolation	Stormwater Infiltration On-lot Sewage Facilities	Wetness Soil mottling Shallow groundwater	Soil testing should be performed if infiltration BMPs or on-lot sewage facilities are proposed. Ammend soils with compost and/or sand.	See geotechnical engineering report or consult the geotechnical professional on record See Appendix A of the PA Stormwater BMP Manual
GgC MaA MaB MaC	Piping		Formation of subsurface tunnels or pipelike cavities by water moving through the soil	Avoid concentrating runoff. Avoid infiltrating in areas with excessive infiltration rates. Install trench plugs, anti-seep collars, key trenches, etc.	See plans See geotechnical engineering report or consult the geotechnical professional on record
GgC MaA MaB MaC	Poor Source of Topsoil	Vegetative Growth/ Stabilization	Low Fertility Droughty or Wet High Acidity	Soil Testsing and appropriate supplementation. Soil amendment/restoration practices	See plan notes
CaB GgC GgC	Wetness	Site work/grading Fill operations	Slow percolation Soil Mottling Shallow groundwater	Concrete stabilization Undercut and replace with suitable material Provide positive drainage	See geotechnical report or consult geotechnical engineer on record

ORDINANCE APPENDIX C

RUNOFF COEFFICIENTS AND CURVE NUMBERS

TABLE C-1. RUNOFF CURVE NUMBERS

Source: Table 2-2a, Table 2-2b, and Table 2-2c from U. S. Department of Agriculture, Natural Resources Conservation Service, June 1986, *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, Second Edition.

TABLE C-2. RATIONAL RUNOFF COEFFICIENTS

Source: Table F.2 from Delaware County Planning Department, December 2011, *Crum Creek Watershed Act 167 Stormwater Management Plan*.

TABLE C-3. MANNING'S 'n' VALUES

Source: Table 3-1 from United States Army Corps of Engineers, January 2010, *HEC-RAS River Analysis System, Hydraulic Reference Manual*, Version 4.1.

FIGURE C-1. REDEVELOPMENT PROJECTS RUNOFF CRITERIA ADJUSTMENT FOR PRE-DEVELOPMENT CONDITIONS

Source: Figure B-3 from the Delaware County Planning Department and Chester County Planning Commission, June 2002, *Act 167 Stormwater Management Plan Chester Creek Watershed.*

TABLE C-1. RUNOFF CURVE NUMBERS
(3 pages)

Source: Table 2-2a, Table 2-2b, and Table 2-2c from U. S. Department of Agriculture, Natural Resources Conservation Service, June 1986, *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR-55)*, Second Edition.

TABLE C-2. RATIONAL RUNOFF COEFFICIENTS
(1 page)

Source: Table F.2 from Delaware County Planning Department, December 2011, *Crum Creek Watershed Act 167 Stormwater Management Plan*.

TABLE C-3. MANNING'S 'n' VALUES
(3 pages)

Source: Table 3-1 from United States Army Corps of Engineers, January 2010, *HEC-RAS River Analysis System, Hydraulic Reference Manual*, Version 4.1.

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

TABLE F-2

RATIONAL RUNOFF COEFFICIENTS

		HYDROLOGIC SOIL GROUP			
LAND USE DESCRIPTION		A	B	C	D
Cultivated land : without conservation treatment		.49	.67	.81	.88
: with conservation treatment		.27	.43	.61	.67
Pasture or range land: poor condition		.38	.63	.78	.84
: good condition		---*	.25	.51	.65
Meadow: good condition		---*	---*	.44	.61
Woods: thin stand, poor cover, no mulch		---*	.34	.59	.70
: good cover		---*	---*	.45	.59
Open spaces, lawns, parks, golf courses, cemeteries					
Good condition: grass cover on 75% or more of the area		---*	.25	.51	.65
Fair condition: grass cover on 50% to 75% of the area		---*	.45	.63	.74
Commercial and business areas (85% impervious)		.84	.90	.93	.96
Industrial districts (72% impervious)		.67	.81	.88	.92
Residential:					
Average lot size	Average % impervious				
1/8 acre or less	65	.59	.76	.86	.90
1/4 acre	38	.25	.49	.67	.78
1/3 acre	30	---*	.49	.67	.78
1/2 acre	25	---*	.45	.65	.76
1 acre	20	---*	.41	.63	.74
Paved parking lots, roofs, driveways, etc.		.99	.99	.99	.99
Streets and roads:					
Paved with curbs and storm sewers		.99	.99	.99	.99
Gravel		.57	.76	.84	.88
Dirt		.49	.69	.80	.84

Notes: Values are based on SCS definitions and are average values.
Values indicated by ---* should be determined by the design engineer based on site characteristics.

Source : New Jersey Department of Environmental Protection, Technical Manual for Stream Encroachment, August 1984

Table 3-1 Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. *Natural Streams*			
1. **Main Channels**			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones			
g. Sluggish reaches, weedy. deep pools	0.045	0.050	0.060
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.050	0.070	0.080
	0.070	0.100	0.150
2. **Flood Plains**			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. **Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged**			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

Table 3-1 (Continued) Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
B. *Lined or Built-Up Channels*			
1. **Concrete**			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
2. **Concrete bottom float finished with sides of:**			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. **Gravel bottom with sides of:**			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. **Brick**			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. **Metal**			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. **Asphalt**			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
7. **Vegetal lining**	0.030		0.500

Table 3-1 (Continued) Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
C. *Excavated or Dredged Channels*			
1. **Earth, straight and uniform**			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. **Earth, winding and sluggish**			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050
3. **Dragline-excavated or dredged**			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. **Rock cuts**			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. **Channels not maintained, weeds and brush**			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

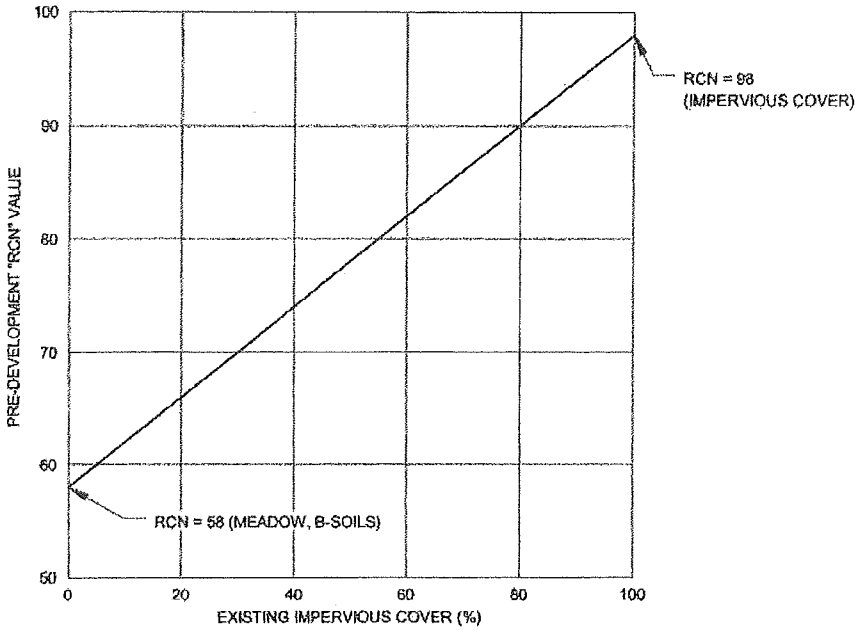
Other sources that include pictures of selected streams as a guide to n value determination are available (Fasken, 1963; Barnes, 1967; and Hicks and Mason, 1991). In general, these references provide color photos with tables of calibrated n values for a range of flows.

Although there are many factors that affect the selection of the n value for the channel, some of the most important factors are the type and size of materials that compose the bed and banks of a channel, and the shape of the channel. Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of Manning's n of a channel. In Cowan's procedure, the value of n is computed by the following equation:

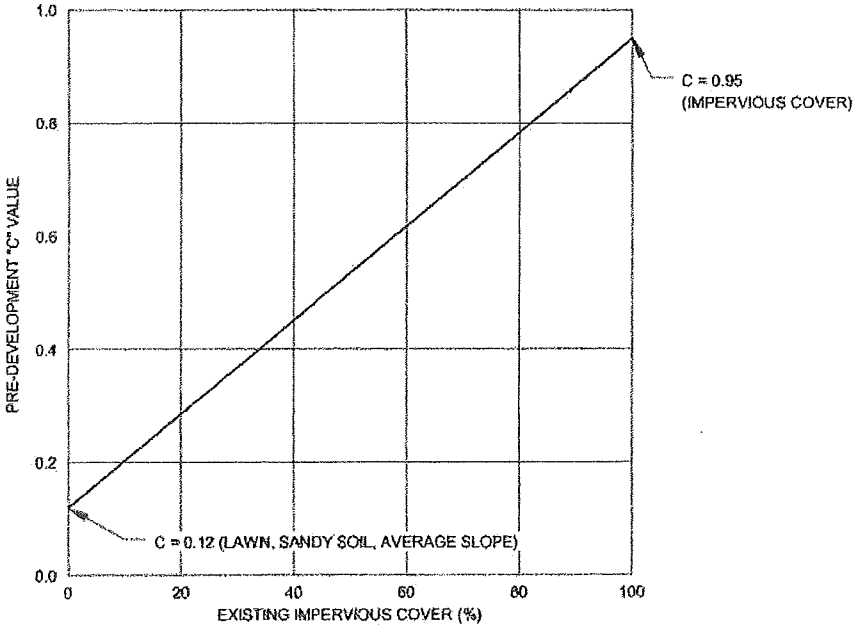
FIGURE C-1

REDEVELOPMENT PROJECTS
RUNOFF CRITERIA ADJUSTMENT FOR PRE-DEVELOPMENT CONDITIONS

NRCS METHODOLOGY
RCN ADJUSTMENT



RATIONAL FORMULA
C ADJUSTMENT



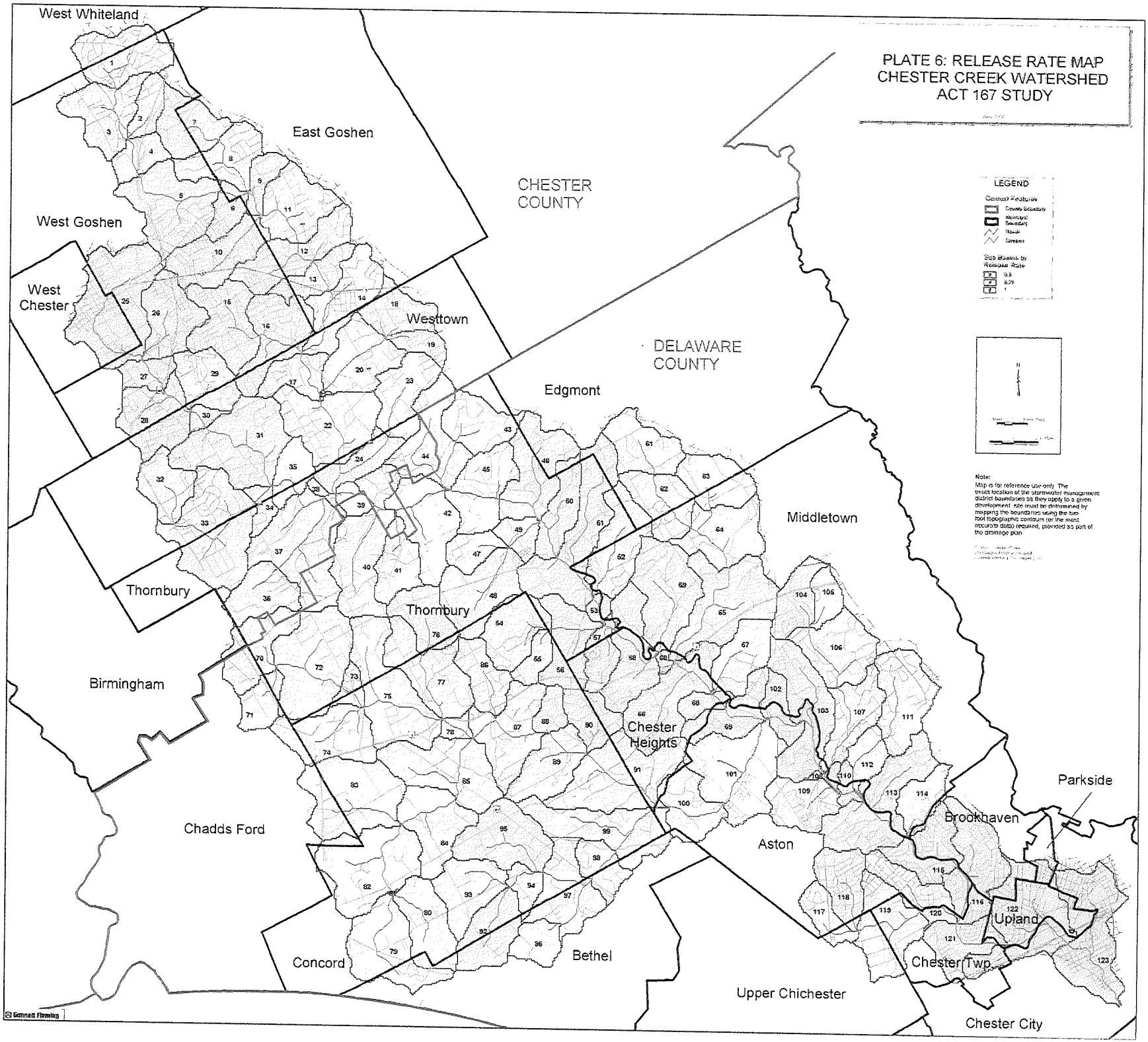


PLATE 6: RELEASE RATE MAP
CHESTER CREEK WATERSHED
ACT 167 STUDY
LEGEND
Context Features
Sub Basins by Release Rate
Note:
Map is for reference use only. The exact location of the stormwater management district boundaries as they apply to a given development site must be determined by mapping the boundaries using the two-foot topographic contours (or the most accurate data) required, provided as part of the drainage plan
CHESTER COUNTY
DELAWARE COUNTY
West Whiteland
East Goshen
West Goshen
West Chester
Westtown
Edgmont
Middletown
Thornbury
Birmingham
Chadds Ford
Concord
Bethel
Upper Chichester
Chester Heights
Aston
Parkside
Brookhaven
Upland
Chester Twp.
Chester City
Gannett Fleming

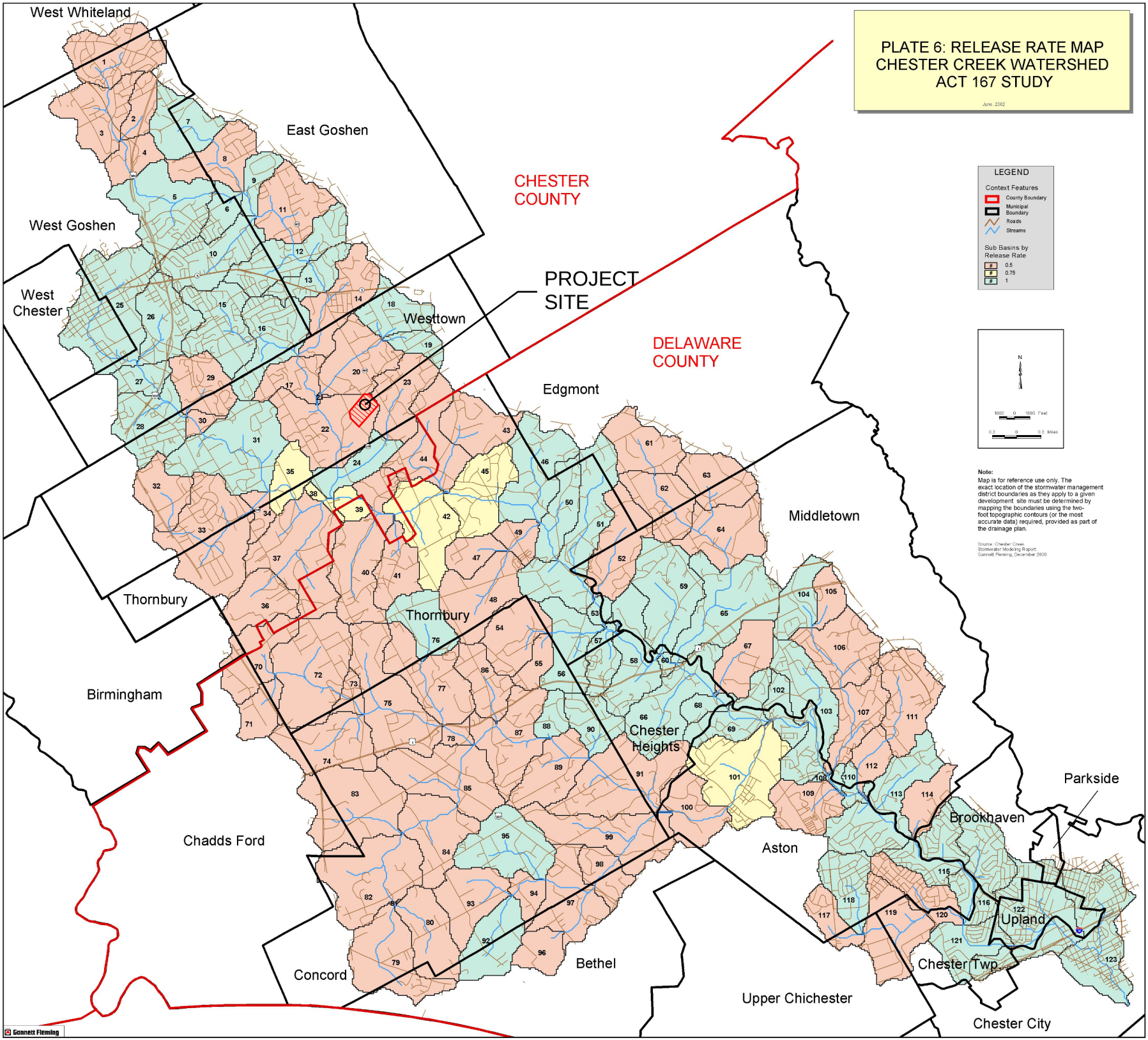


PLATE 6: RELEASE RATE MAP
CHESTER CREEK WATERSHED
ACT 167 STUDY
June, 2002
LEGEND
Context Features
County Boundary
Municipal Boundary
Roads
Streams
Sub Basins by Release Rate
0.5
0.75
1
Note:
Map is for reference use only. The exact location of the stormwater management district boundaries as they apply to a given development site must be determined by mapping the boundaries using the two-foot topographic contours (or the most accurate data) required, provided as part of the drainage plan.
Source: Chester Creek Stormwater Modeling Report Gannett Fleming, December 2000
CHESTER COUNTY
DELAWARE COUNTY
PROJECT SITE
West Whiteland
East Goshen
West Goshen
West Chester
Westtown
Edgmont
Middletown
Thornbury
Birmingham
Chadds Ford
Concord
Bethel
Aston
Chester Heights
Parkside
Brookhaven
Upland
Chester Twp.
Upper Chichester
Chester City
Gannett Fleming

NOAA Atlas 14, Volume 2, Version 3
Location name: West Chester, Pennsylvania, USA*
Latitude: 39.9456°, Longitude: -75.5371°
Elevation: 319.37 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.353** (0.323-0.385)	**0.421** (0.386-0.459)	**0.492** (0.450-0.537)	**0.542** (0.495-0.591)	**0.600** (0.546-0.655)	**0.640** (0.578-0.699)	**0.679** (0.611-0.742)	**0.712** (0.637-0.781)	**0.750** (0.665-0.825)	**0.778** (0.684-0.860)
10-min	**0.563** (0.517-0.615)	**0.673** (0.617-0.734)	**0.788** (0.720-0.859)	**0.866** (0.791-0.946)	**0.957** (0.870-1.04)	**1.02** (0.921-1.11)	**1.08** (0.971-1.18)	**1.13** (1.01-1.24)	**1.19** (1.05-1.31)	**1.23** (1.08-1.36)
15-min	**0.704** (0.646-0.769)	**0.846** (0.775-0.923)	**0.996** (0.911-1.09)	**1.10** (1.00-1.20)	**1.21** (1.10-1.32)	**1.29** (1.17-1.41)	**1.36** (1.23-1.49)	**1.42** (1.27-1.56)	**1.49** (1.32-1.64)	**1.54** (1.35-1.70)
30-min	**0.966** (0.885-1.06)	**1.17** (1.07-1.27)	**1.42** (1.30-1.54)	**1.59** (1.45-1.73)	**1.80** (1.63-1.96)	**1.94** (1.76-2.12)	**2.09** (1.88-2.28)	**2.22** (1.98-2.43)	**2.38** (2.11-2.62)	**2.49** (2.19-2.75)
60-min	**1.20** (1.10-1.32)	**1.47** (1.34-1.60)	**1.82** (1.66-1.98)	**2.07** (1.89-2.26)	**2.39** (2.17-2.61)	**2.63** (2.38-2.88)	**2.88** (2.59-3.15)	**3.11** (2.78-3.41)	**3.41** (3.02-3.75)	**3.64** (3.20-4.02)
2-hr	**1.44** (1.31-1.59)	**1.75** (1.59-1.93)	**2.17** (1.97-2.40)	**2.50** (2.26-2.76)	**2.93** (2.63-3.22)	**3.27** (2.92-3.60)	**3.60** (3.20-3.97)	**3.94** (3.47-4.35)	**4.39** (3.83-4.86)	**4.74** (4.09-5.27)
3-hr	**1.56** (1.42-1.73)	**1.90** (1.73-2.09)	**2.37** (2.15-2.61)	**2.73** (2.47-3.01)	**3.20** (2.88-3.53)	**3.58** (3.20-3.94)	**3.96** (3.52-4.36)	**4.34** (3.82-4.79)	**4.86** (4.22-5.38)	**5.25** (4.51-5.83)
6-hr	**1.93** (1.75-2.14)	**2.33** (2.12-2.58)	**2.90** (2.63-3.21)	**3.36** (3.03-3.71)	**3.99** (3.58-4.41)	**4.51** (4.01-4.97)	**5.05** (4.45-5.57)	**5.61** (4.89-6.19)	**6.39** (5.48-7.09)	**7.01** (5.93-7.82)
12-hr	**2.35** (2.13-2.62)	**2.83** (2.57-3.16)	**3.55** (3.21-3.95)	**4.14** (3.73-4.60)	**4.99** (4.45-5.54)	**5.71** (5.05-6.33)	**6.48** (5.66-7.19)	**7.32** (6.30-8.14)	**8.53** (7.19-9.51)	**9.53** (7.89-10.7)
24-hr	**2.71** (2.49-2.96)	**3.26** (3.00-3.56)	**4.10** (3.76-4.48)	**4.80** (4.39-5.23)	**5.81** (5.29-6.33)	**6.66** (6.03-7.24)	**7.58** (6.82-8.23)	**8.57** (7.67-9.30)	**10.0** (8.87-10.9)	**11.2** (9.85-12.2)
2-day	**3.13** (2.87-3.43)	**3.78** (3.47-4.14)	**4.76** (4.36-5.20)	**5.55** (5.08-6.07)	**6.69** (6.09-7.31)	**7.63** (6.92-8.33)	**8.64** (7.79-9.42)	**9.71** (8.70-10.6)	**11.3** (9.99-12.3)	**12.5** (11.0-13.7)
3-day	**3.30** (3.03-3.62)	**3.98** (3.66-4.36)	**5.00** (4.59-5.46)	**5.83** (5.33-6.37)	**7.00** (6.38-7.65)	**7.98** (7.24-8.70)	**9.02** (8.14-9.83)	**10.1** (9.08-11.0)	**11.7** (10.4-12.8)	**13.0** (11.5-14.2)
4-day	**3.47** (3.19-3.80)	**4.19** (3.85-4.58)	**5.24** (4.81-5.73)	**6.10** (5.59-6.66)	**7.32** (6.67-7.99)	**8.33** (7.56-9.08)	**9.40** (8.49-10.2)	**10.5** (9.46-11.5)	**12.2** (10.8-13.3)	**13.5** (11.9-14.7)
7-day	**4.06** (3.77-4.41)	**4.87** (4.51-5.29)	**6.03** (5.58-6.55)	**6.98** (6.45-7.57)	**8.34** (7.68-9.04)	**9.47** (8.67-10.2)	**10.7** (9.72-11.5)	**12.0** (10.8-12.9)	**13.8** (12.4-14.9)	**15.3** (13.6-16.6)
10-day	**4.62** (4.30-4.98)	**5.52** (5.14-5.95)	**6.73** (6.26-7.26)	**7.71** (7.16-8.31)	**9.08** (8.40-9.77)	**10.2** (9.40-11.0)	**11.3** (10.4-12.2)	**12.5** (11.4-13.5)	**14.2** (12.9-15.3)	**15.6** (14.0-16.8)
20-day	**6.24** (5.84-6.69)	**7.41** (6.94-7.93)	**8.84** (8.27-9.47)	**9.97** (9.31-10.7)	**11.5** (10.7-12.3)	**12.7** (11.8-13.6)	**13.9** (12.9-14.9)	**15.1** (13.9-16.2)	**16.8** (15.4-18.0)	**18.0** (16.4-19.4)
30-day	**7.77** (7.32-8.24)	**9.16** (8.63-9.72)	**10.7** (10.1-11.3)	**11.9** (11.2-12.6)	**13.4** (12.6-14.3)	**14.6** (13.7-15.5)	**15.8** (14.8-16.8)	**17.0** (15.8-18.0)	**18.5** (17.1-19.6)	**19.6** (18.1-20.9)
45-day	**9.86** (9.35-10.4)	**11.6** (11.0-12.2)	**13.3** (12.6-14.1)	**14.6** (13.9-15.5)	**16.3** (15.4-17.2)	**17.6** (16.6-18.5)	**18.7** (17.7-19.8)	**19.8** (18.7-21.0)	**21.2** (19.9-22.4)	**22.2** (20.8-23.5)
60-day	**11.8** (11.2-12.4)	**13.8** (13.2-14.6)	**15.8** (15.0-16.6)	**17.3** (16.4-18.2)	**19.1** (18.1-20.1)	**20.4** (19.4-21.5)	**21.7** (20.5-22.8)	**22.8** (21.6-24.0)	**24.2** (22.9-25.5)	**25.2** (23.8-26.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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NOAA Atlas 14, Volume 2, Version 3
Location name: West Chester, Pennsylvania, USA*
Latitude: 39.9456°, Longitude: -75.5371°
Elevation: 319.37 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**4.24** (3.88-4.62)	**5.05** (4.63-5.51)	**5.90** (5.40-6.44)	**6.50** (5.94-7.09)	**7.20** (6.55-7.86)	**7.68** (6.94-8.39)	**8.15** (7.33-8.90)	**8.54** (7.64-9.37)	**9.00** (7.98-9.90)	**9.34** (8.21-10.3)
10-min	**3.38** (3.10-3.69)	**4.04** (3.70-4.40)	**4.73** (4.32-5.15)	**5.20** (4.75-5.68)	**5.74** (5.22-6.26)	**6.11** (5.53-6.68)	**6.47** (5.83-7.08)	**6.77** (6.06-7.43)	**7.12** (6.31-7.84)	**7.35** (6.46-8.13)
15-min	**2.82** (2.58-3.08)	**3.38** (3.10-3.69)	**3.98** (3.64-4.35)	**4.38** (4.00-4.78)	**4.85** (4.41-5.29)	**5.16** (4.66-5.64)	**5.46** (4.91-5.96)	**5.70** (5.10-6.25)	**5.97** (5.29-6.57)	**6.15** (5.41-6.80)
30-min	**1.93** (1.77-2.11)	**2.34** (2.14-2.55)	**2.83** (2.59-3.09)	**3.17** (2.90-3.47)	**3.59** (3.27-3.92)	**3.89** (3.51-4.24)	**4.18** (3.76-4.57)	**4.43** (3.97-4.86)	**4.75** (4.21-5.23)	**4.98** (4.38-5.51)
60-min	**1.20** (1.10-1.32)	**1.47** (1.34-1.60)	**1.82** (1.66-1.98)	**2.07** (1.89-2.26)	**2.39** (2.17-2.61)	**2.63** (2.38-2.88)	**2.88** (2.59-3.15)	**3.11** (2.78-3.41)	**3.41** (3.02-3.75)	**3.64** (3.20-4.02)
2-hr	**0.719** (0.652-0.792)	**0.874** (0.794-0.964)	**1.09** (0.986-1.20)	**1.25** (1.13-1.38)	**1.47** (1.32-1.61)	**1.63** (1.46-1.80)	**1.80** (1.60-1.99)	**1.97** (1.74-2.17)	**2.20** (1.91-2.43)	**2.37** (2.04-2.63)
3-hr	**0.521** (0.474-0.575)	**0.632** (0.575-0.697)	**0.789** (0.716-0.869)	**0.908** (0.822-1.00)	**1.07** (0.959-1.17)	**1.19** (1.07-1.31)	**1.32** (1.17-1.45)	**1.45** (1.27-1.60)	**1.62** (1.40-1.79)	**1.75** (1.50-1.94)
6-hr	**0.322** (0.293-0.357)	**0.389** (0.354-0.431)	**0.484** (0.439-0.536)	**0.560** (0.507-0.620)	**0.667** (0.598-0.736)	**0.752** (0.670-0.830)	**0.843** (0.743-0.930)	**0.937** (0.817-1.03)	**1.07** (0.915-1.18)	**1.17** (0.990-1.31)
12-hr	**0.195** (0.177-0.218)	**0.235** (0.213-0.262)	**0.294** (0.267-0.328)	**0.343** (0.309-0.382)	**0.415** (0.370-0.460)	**0.474** (0.419-0.525)	**0.538** (0.470-0.597)	**0.607** (0.523-0.675)	**0.708** (0.597-0.789)	**0.791** (0.655-0.885)
24-hr	**0.113** (0.104-0.123)	**0.136** (0.125-0.149)	**0.171** (0.157-0.187)	**0.200** (0.183-0.218)	**0.242** (0.220-0.264)	**0.277** (0.251-0.302)	**0.316** (0.284-0.343)	**0.357** (0.319-0.388)	**0.418** (0.370-0.453)	**0.468** (0.410-0.508)
2-day	**0.065** (0.060-0.071)	**0.079** (0.072-0.086)	**0.099** (0.091-0.108)	**0.116** (0.106-0.127)	**0.139** (0.127-0.152)	**0.159** (0.144-0.173)	**0.180** (0.162-0.196)	**0.202** (0.181-0.221)	**0.234** (0.208-0.256)	**0.261** (0.230-0.284)
3-day	**0.046** (0.042-0.050)	**0.055** (0.051-0.061)	**0.069** (0.064-0.076)	**0.081** (0.074-0.088)	**0.097** (0.089-0.106)	**0.111** (0.101-0.121)	**0.125** (0.113-0.137)	**0.141** (0.126-0.153)	**0.163** (0.145-0.177)	**0.181** (0.159-0.197)
4-day	**0.036** (0.033-0.040)	**0.044** (0.040-0.048)	**0.055** (0.050-0.060)	**0.064** (0.058-0.069)	**0.076** (0.070-0.083)	**0.087** (0.079-0.095)	**0.098** (0.088-0.107)	**0.110** (0.099-0.120)	**0.127** (0.113-0.138)	**0.141** (0.124-0.153)
7-day	**0.024** (0.022-0.026)	**0.029** (0.027-0.031)	**0.036** (0.033-0.039)	**0.042** (0.038-0.045)	**0.050** (0.046-0.054)	**0.056** (0.052-0.061)	**0.064** (0.058-0.069)	**0.071** (0.064-0.077)	**0.082** (0.074-0.089)	**0.091** (0.081-0.099)
10-day	**0.019** (0.018-0.021)	**0.023** (0.021-0.025)	**0.028** (0.026-0.030)	**0.032** (0.030-0.035)	**0.038** (0.035-0.041)	**0.042** (0.039-0.046)	**0.047** (0.043-0.051)	**0.052** (0.048-0.056)	**0.059** (0.054-0.064)	**0.065** (0.058-0.070)
20-day	**0.013** (0.012-0.014)	**0.015** (0.014-0.017)	**0.018** (0.017-0.020)	**0.021** (0.019-0.022)	**0.024** (0.022-0.026)	**0.026** (0.025-0.028)	**0.029** (0.027-0.031)	**0.032** (0.029-0.034)	**0.035** (0.032-0.037)	**0.038** (0.034-0.040)
30-day	**0.011** (0.010-0.011)	**0.013** (0.012-0.013)	**0.015** (0.014-0.016)	**0.016** (0.016-0.017)	**0.019** (0.018-0.020)	**0.020** (0.019-0.022)	**0.022** (0.020-0.023)	**0.024** (0.022-0.025)	**0.026** (0.024-0.027)	**0.027** (0.025-0.029)
45-day	**0.009** (0.009-0.010)	**0.011** (0.010-0.011)	**0.012** (0.012-0.013)	**0.014** (0.013-0.014)	**0.015** (0.014-0.016)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.017-0.019)	**0.020** (0.018-0.021)	**0.021** (0.019-0.022)
60-day	**0.008** (0.008-0.009)	**0.010** (0.009-0.010)	**0.011** (0.010-0.012)	**0.012** (0.011-0.013)	**0.013** (0.013-0.014)	**0.014** (0.013-0.015)	**0.015** (0.014-0.016)	**0.016** (0.015-0.017)	**0.017** (0.016-0.018)	**0.018** (0.016-0.018)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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APPENDIX D
SUPPORTING VOLUME CALCULATIONS
(EAST BRANCH CHESTER CREEK)

Worksheet 4. Change in Runoff Volume for 2-YR Storm Event

East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project

Drainage Area East Branch Chester Creek

2-Year Rainfall: 3.26 in

Existing Conditions:

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	6,143	0.141	98	0.20	0.04	3.03	1,550
Meadow	B	203,696	4.676	58	7.24	1.45	0.36	6,154
40% Impervious Area as Meadow	B	4095	0.094	58	7.24	1.45	0.36	124
TOTAL:		213,934	4.911				3.75	7,828

Developed Conditions:

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	51,664	1.186	98	0.20	0.04	3.03	13,033
Lawn (Good condition)	B	147,588	3.388	61	6.39	1.28	0.47	5,765
TOTAL:		199,252	4.574				3.50	18,798

2-Year Volume Increase (ft^3): 10,971

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P-0.2S)^2 / (P+0.8S)$ where P = 2-Year Rainfall (in) S = (1000 / CN) - 10
2. Runoff Volume (CF) = Q x Area x 1/12 Q = Runoff (in) Area = Land use area (sq. ft)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

BMP Volume Calculation Worksheet

PROJECT: The Westtown School - Oak Lane Project

2-Year Rainfall: 3.26 in

Drainage Area Name: Infiltration BMP 1

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia ((0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Disturbed Area								
Lawn (Good condition)	B	99734	2.29	61	6.39	1.28	0.47	3,896
Paved/Impervious Areas	B	46644	1.07	98	0.20	0.04	3.03	11,767
TOTAL ONSITE:		146378	3.36					15,663
Undisturbed Area								
Lawn (Good condition)	B	63893	1.47	61	6.39	1.28	0.47	2,496
Paved/Impervious Areas	B	6916	0.16	98	0.20	0.04	3.03	1,745
TOTAL:		217187	4.99					19,903

1. Runoff (in) = $Q = (P-0.2S)^2 / (P+0.8S)$ where
   P = 2-Year Rainfall (in)
   S=(1000 / CN) - 10
2. Runoff Volume (CF) = Q x Area x 1/12
   Q=Runoff (in)
   Area = Land use area (sq. ft)

Infiltration BMP 1 Calculations

Infiltration Volume

Inf Rate:	0.41	in/hr
Inf Area:	10,675	sf

Storage Volume = 11,503 cf at elev: 289.50

Infiltration Volume = Inf. Rate x Inf Area X Inf Period
= 0.41 in/hr x 10,675 sf x 2 hr x (1ft/12in)
= 724 CF

Total Inf. Volume[1] = Storage Volume + Infiltration Volume
= 12,227 cf at elev: 289.5

Volume Captured = 15,663 cf

Infiltration Credit = 11,161 cf^2
ET Credit = 3277 cf^2
Total Credits 14,438

Test Pit	Infiltration Rate (in/hr)
TP-14A	0.20
TP-14B	1.00
TP-15A*	~~0.00~~
TP-15B*	~~0.00~~
TP-16A	2.70
TP-16B*	~~6.00~~
Geomean	0.81
Safety Factor	2.00
Adjusted Rate	0.41

*The highest and lowest recorded rates were removed from the calculation.

Loading Ratios

Total Drainage Area = 217,187 sf
Impervious Area = 53,560 sf
Infiltration Area = 10,675 sf
Impervious Loading Ratio = 5.0:1
Overall Loading Ratio = 20.3:1

Dewatering Time (After Rainfall Event)

$$T = \frac{\text{Infiltration Volume}}{(\text{Inf. Rate}/12 \times \text{Inf. Area})}$$

= **33.8 hrs**

[1] For dewatering calculation analysis

[2] See PADEP PCSM Volume Spreadsheet

UNT. TO
EAST BRANCH CHESTER CREEK

Worksheet 4. Change in Runoff Volume for 2-YR Storm Event

UNT to East Branch Chester Creek

PROJECT: The Westtown School - Oak Lane Project

Drainage Area Unt. to East Branch Chester Creek

2-Year Rainfall: 3.26 in

Existing Conditions:

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	263	0.006	98	0.20	0.04	3.03	66
Meadow	B	502,049	11.525	58	7.24	1.45	0.36	15,169
40% Impervious Area as Meadow	B	175	0.004	58	7.24	1.45	0.36	5
Meadow	D	49,830	1.144	78	2.82	0.56	1.32	5,471
TOTAL:		552,317	12.679				3.75	20,711

Developed Conditions:

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia (0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	206,620	4.743	98	0.20	0.04	3.03	52,125
Lawn (Good condition)	B	310,539	7.129	61	6.39	1.28	0.47	12,130
Lawn (Good condition)	D	49,830	1.144	80	2.50	0.50	1.45	6,014
TOTAL:		566,989	13.016				4.94	70,268

2-Year Volume Increase (ft^3): 49,557

2-Year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

1. Runoff (in) = $Q = (P-0.2S)^2 / (P+0.8S)$ where P = 2-Year Rainfall (in) S = (1000 / CN) - 10
2. Runoff Volume (CF) = Q x Area x 1/12 Q = Runoff (in) Area = Land use area (sq. ft)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.

BMP Volume Calculation Worksheet

PROJECT: The Westtown School - Oak Lane Project

2-Year Rainfall: 3.26 in

Drainage Area Name: Infiltration Bed - BMP 2

Cover Type/Condition **Disturbed Area**	Soil Type	Area (sf)	Area (ac)	CN	S	Ia ((0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	96824	2.22	98	0.20	0.04	3.03	24,426
Lawn (Good condition)	B			61	6.39	1.28	0.47	0
Lawn (Good condition)	D			80	2.50	0.50	1.45	0
TOTAL ONSITE:		96824	2.22					24,426

Drainage Area Name: Infiltration Bed - BMP 3

Cover Type/Condition **Disturbed Area**	Soil Type	Area (sf)	Area (ac)	CN	S	Ia ((0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Paved/Impervious Areas	B	96824	2.22	98	0.20	0.04	3.03	24,426
Lawn (Good condition)	B			61	6.39	1.28	0.47	0
Lawn (Good condition)	D			80	2.50	0.50	1.45	0
TOTAL ONSITE:		96824	2.22					24,426
			Volume Infiltrated (from DEP PCSM Spreadsheet)					24,357
			Overflow volume to BMP 4					69

1. Runoff (in) = $Q = (P-0.2S)^2 / (P+0.8S)$ where

P = 2-Year Rainfall (in)

S=(1000 / CN) - 10

BMP Volume Calculation Worksheet

PROJECT: The Westtown School - Oak Lane Project

2-Year Rainfall: 3.26 in

Drainage Area Name: Infiltration Basin - BMP 4

Cover Type/Condition	Soil Type	Area (sf)	Area (ac)	CN	S	Ia ((0.2*S)	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Disturbed Area								
Paved/Impervious Areas	B	12972	0.30	98	0.20	0.04	3.03	3,272
Lawn (Good condition)	B	222976	5.12	61	6.39	1.28	0.47	8,710
Lawn (Good condition)	D	23706	0.54	80	2.50	0.50	1.45	2,861
TOTAL ONSITE:		259654	5.96					14,843
							Additional Volume from BMP 3	69
							Volume Routed to BMP	14,912
Undisturbed Area								
Paved/Impervious Areas	B			98	0.20	0.04	3.03	0
Lawn (Good condition)	B	121339	2.79	61	6.39	1.28	0.47	4,740
Lawn (Good condition)	D	40248	0.92	80	2.50	0.50	1.45	4,857
TOTAL:		421241	9.67					24,440

1. Runoff (in) = $Q = (P-0.2S)^2 / (P+0.8S)$ where

   P = 2-Year Rainfall (in)

   S=(1000 / CN) - 10

2. Runoff Volume (CF) = Q x Area x 1/12

   Q=Runoff (in)

   Area = Land use area (sq. ft)

S=(1000 / CN) - 10

2. Runoff Volume (CF) = Q x Area x 1/12

Q=Runoff (in)

Area = Land use area (sq. ft)

Infiltration Bed - BMP 2 Calculations

Subsurface Infiltration Bed Volume

Inf Rate:	2.32	in/hr
Inf Area:	75,725	sf

Storage Volume = 23,035 cf at elev: 316.75

Infiltration Volume = Inf. Rate x Inf Area X Inf Period
= 2.32 in/hr x 75,725 sf x 2 hr x (1ft/12in)
= 29328 CF

Total Inf. Volume = Storage Volume + Infiltration Volume
= 52,363 cf at elev: 316.75

Volume Captured = 24,426 cf

Volume Infiltrated = 24,426 cf

Test Pit	Infiltration Rate (in/hr)
TP-1A	1.80
TP-3B	12.00
Geomean	4.65
Safety Factor	2.00
Adjusted Rate	2.32

Loading Ratios

Total Drainage Area = 96824 sf
Impervious Area = 96824 sf
Infiltration Area = 75,725 sf
Impervious Loading Ratio = 1.3:1
Overall Loading Ratio = 1.3:1

Dewatering Time (After Rainfall Event)

$$T = \frac{\text{Infiltration Volume}}{(\text{Inf. Rate}/12 \times \text{Inf. Area})}$$

= **1.7 hrs**

Synthetic Turf Field Storage Calculations

BMP 2

WATER SURFACE ELEVATION (FEET)	SUBGRADE AREA (SQ.FT.)	AVERAGE AREA (SQ.FT.)	Δ ELEV. (FEET)	STORAGE VOLUME	x 0.40 (40% Void space)	Σ (CU.FT.)	(AC. FT.)
316	75725					0	0
		75725	0.67	50,736	20294		
316.67	75725					20,294	0.4659
		85638	0.08	6,851	2740		
316.75	95550					23,035	0.5288
		95550	0.75	71,663	28665		
317.5	95550					51,700	1.1869
		0	0.00	0	0		
						0	0.0000
		0	0.00	0	0		
						0	0.0000
		0	0.00	0	0		
						0	0.0000

Infiltration Bed - BMP 3 Calculations

Subsurface Infiltration Bed Volume

Inf Rate:	1.01	in/hr
Inf Area:	26,795	sf

Storage Volume = 21,916 cf at elev: 321.00

Infiltration Volume = Inf. Rate x Inf Area X Inf Period
= 1.01 in/hr x 26,795 sf x 2 hr x (1ft/12in)
= 4510 CF

Total Inf. Volume = Storage Volume + Infiltration Volume
= 26,426 cf at elev: 321

Volume Captured = 24,426 cf

Volume Infiltrated = 24,357 cf

Test Pit	Infiltration Rate (in/hr)
TP-4A	1.20
TP-5A	3.40
Geomean	2.02
Safety Factor	2.00
Adjusted Rate	1.01

Loading Ratios

Total Drainage Area = 96824 sf
Impervious Area = 96824 sf
Infiltration Area = 26,795 sf
Impervious Loading Ratio = 3.6:1
Overall Loading Ratio = 3.6:1

Dewatering Time (After Rainfall Event)

$$T = \frac{\text{Infiltration Volume}}{(\text{Inf. Rate}/12 \times \text{Inf. Area})}$$

= **10.8 hrs**

Synthetic Turf Field Storage Calculations

BMP 3

WATER SURFACE ELEVATION (FEET)	SUBGRADE AREA (SQ.FT.)	AVERAGE AREA (SQ.FT.)	Δ ELEV. (FEET)	STORAGE VOLUME	x 0.40 (40% Void space)	Σ (CU.FT.)	(AC. FT.)
319	26795					0	0
		27195	1.00	27,195	10878		
320	27595					10,878	0.2497
		27595	1.00	27,595	11038		
321	27595					21,916	0.5031
		56028	0.65	36,418	14567		
321.65	84460					36,483	0.8375
		90005	0.10	9,001	3600		
321.75	95550					40,083	0.9202
		95550	0.75	71,663	28665		
322.5	95550					68,748	1.5782
		0	0.00	0	0		
						0	0.0000

Infiltration Basin - BMP 4 Calculations

Infiltration Volume

Inf Rate:	0.84	in/hr
Inf Area:	19,809	sf

Storage Volume = 22,478 cf at elev: 311.00

Infiltration Volume = Inf. Rate x Inf Area X Inf Period
= 0.84 in/hr x 19,809 sf x 2 hr x (1ft/12in)
= 2762 CF

Total Inf. Volume = Storage Volume + Infiltration Volume
= 25,240 cf at elev: 311.00

Volume Captured = 14,843 cf

Overflow volume from BMP 3 = 69
Total Volume Captured[1]= 14,912

Volume Infiltrated[1] = 14,912 cf[2]
ET Credit[1]= 0 cf[2]
Total Credit= 14,912

Test Pit	Infiltration Rate (in/hr)
TP-6A	1.00
TP-7B	2.80
Geomean	1.67
Safety Factor	2.00
Adjusted Rate	0.84

Loading Ratios

Total Drainage Area = 421241 sf
Impervious Area = 12972 sf
Infiltration Area = 19,809 sf
Impervious Loading Ratio = 0.7:1
Overall Loading Ratio = 21.3:1

Dewatering Time (After Rainfall Event)

$$T = \frac{\text{Storage Volume}}{(\text{Inf. Rate}/12 \times \text{Inf. Area})}$$

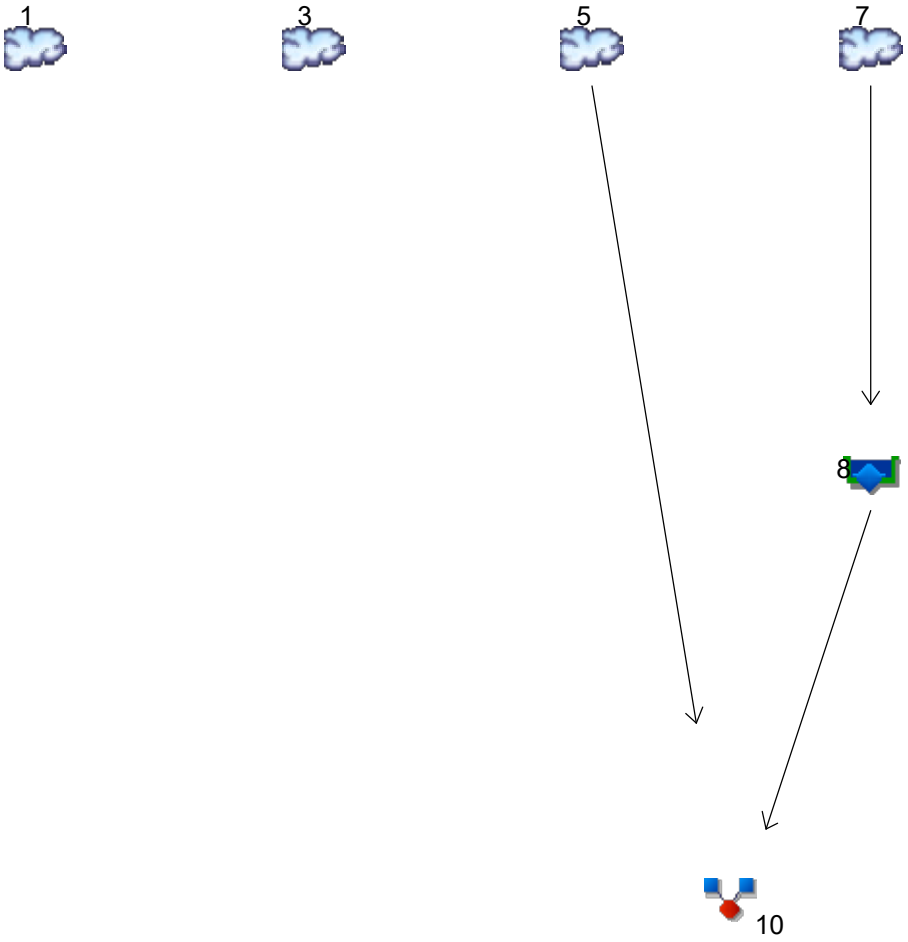
= **16.3 hrs**

[1] See PADEP PCSM Volume Spreadsheet

APPENDIX E
RATE CONTROL ANALYSIS

OVERALL HYDROLOGY

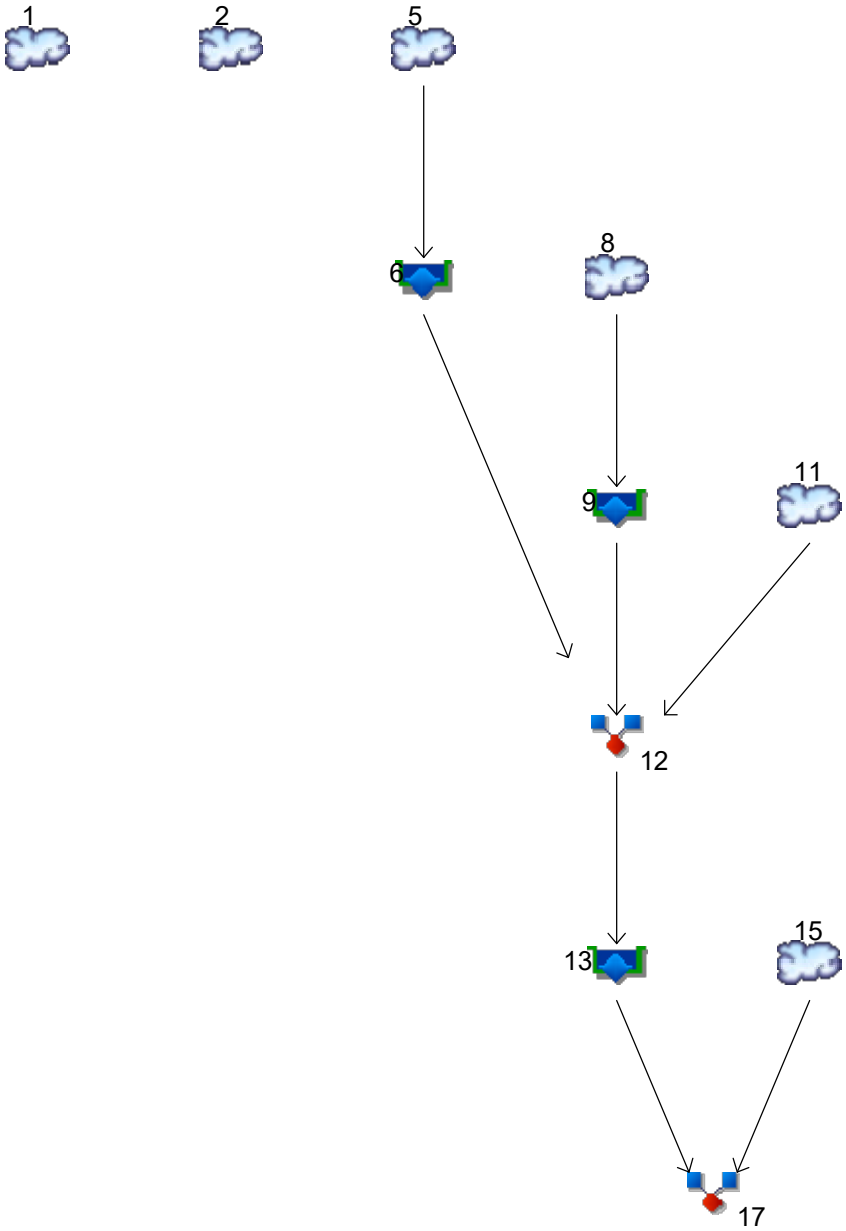
Watershed Model Schematic



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	0.857	2.379	-------	5.681	8.961	14.25	19.09	24.73	Pre-Dev. (E. Branch Chester Creek)
3	SCS Runoff	------	0.498	1.525	-------	3.844	6.212	10.05	13.58	17.68	Pre-Dev. (EBCC) Onsite
5	SCS Runoff	------	0.678	1.267	-------	2.311	3.279	4.785	6.123	7.622	EBCC-Undetained
7	SCS Runoff	------	3.519	5.831	-------	9.819	13.44	19.04	24.03	29.58	BMP 1 IN
8	Reservoir	7	0.000	0.162	-------	0.667	1.829	5.137	8.706	13.69	BMP 1 Routed
10	Combine	5, 8,	0.678	1.267	-------	2.311	3.279	5.795	9.564	14.78	Post-Dev. E. Branch Chester (Combi

Watershed Model Schematic



Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	1.827	5.020	-------	12.03	19.34	31.25	42.19	54.74	Pre-Dev. (Unt. to EBCC)
2	SCS Runoff	------	1.333	3.664	-------	8.779	14.12	22.81	30.80	39.96	Pre-Dev. Unt. to EBCC Onsite (Redu
5	SCS Runoff	------	8.084	9.771	-------	12.34	14.48	17.55	20.14	22.94	BMP 3 IN
6	Reservoir	5	0.000	0.006	-------	0.076	0.116	0.165	0.219	0.435	BMP 3 Routed
8	SCS Runoff	------	8.084	9.771	-------	12.34	14.48	17.55	20.14	22.94	BMP 2 IN
9	Reservoir	8	0.000	0.000	-------	0.148	0.319	0.762	1.333	2.110	BMP 2 Routed
11	SCS Runoff	------	2.564	5.132	-------	10.10	14.80	22.21	28.86	36.45	BMP 4 DA
12	Combine	6, 9, 11	2.564	5.132	-------	10.10	14.80	22.76	30.13	38.61	BMP 4 IN
13	Reservoir	12	0.000	0.019	-------	0.745	2.040	7.989	15.12	23.74	BMP 4 Routed
15	SCS Runoff	------	1.201	2.510	-------	4.941	7.232	10.84	14.08	17.79	Unt. to EBCC Undetained
17	Combine	13, 15,	1.201	2.510	-------	4.941	7.232	10.84	17.45	26.78	Post-Dev. Unt. to EBCC (Combined)

PRE-DEVELOPMENT HYDROLOGY
(EAST BRANCH CHESTER CREEK)

ELA SPORT

ATHLETIC FACILITIES DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

	LAND USE	Parking, Other Impervious (60% of total)	40% of Impervious Areas as Meadow	Meadow	Meadow			
	HSG	B	B	B	D			
	"CN" Value	98	58	58	78	Total	Composite	
WATERSHED		Area (ac)				Area (ac.)	'CN' Value	Tc Min.
Pre-Dev. EBCC		0.26	0.17	6.17	0.00	6.60	60	15
Pre-Dev. EBCC 'Onsite' (Reduction Factor)		0.14	0.09	4.68	0.00	4.91	59	15

ELA SPORT
ATHLETIC FACILITIES
DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

SUMMARY - SUBAREAS TIME OF CONCENTRATION PRE-DEVELOPMENT CONDITIONS

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

Time of concentration (Tc) or travel time (Tt)

	overland					Shallow Concentrated					Channel or Pipe								Total	
Watershed	Length L_1 100 ft. max.	Slope S_1	Manning's n	2 yr rainfall	Tc	Flow Path Cover	Length L_2	Slope S_2	Average Velocity	Tt	Channel or Pipe	Flow Area	Wetted Perimeter	Pipe Diameter	Slope S_3	Manning's n	Length L_3	Tt	Σ Tc	
	ft.	ft./ft.	n	in.	Min.	U/P	ft.	ft./ft.	ft./s	Min.	C/P	sq.ft.	ft.	in.	ft./ft.	n	ft.	Min.	Min.	Hrs.
A	89	0.017	0.24	3.26	14				0	0.0		0.00	0.00					0		
					0	U	234	0.090	4.8	0.8		0.00	0.00					0		
					0				0	0		0.00	0.00					0		
					0				0	0		0.00	0.00					0		
					0				0	0		0.00	0.00					0.0		
					13.7					0.8								0.0	**15**	0.25

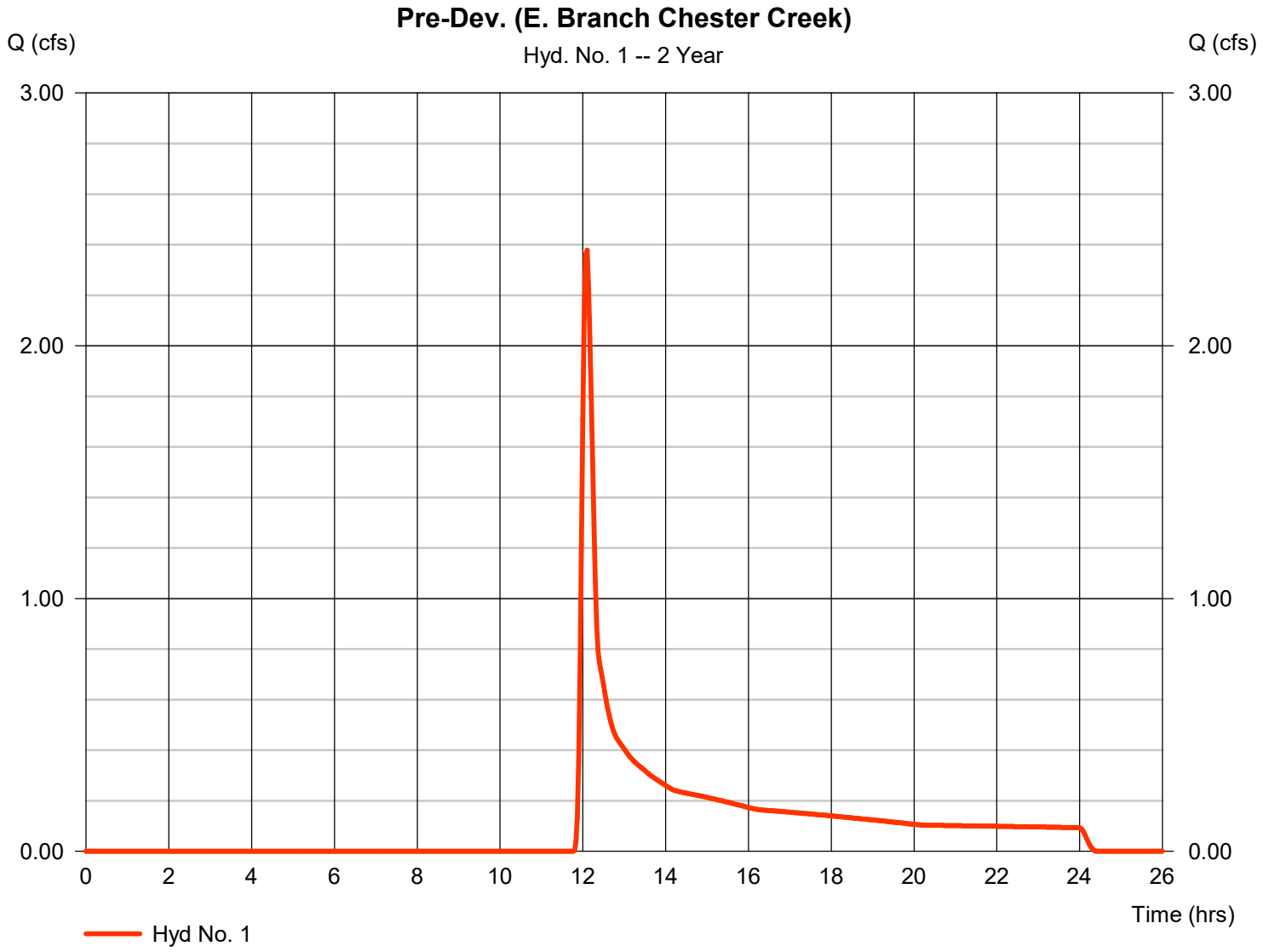
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	= SCS Runoff	Peak discharge	= 2.379 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 10,087 cuft
Drainage area	= 6.600 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 3.26 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	= SCS Runoff	Peak discharge	= 5.681 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 18,953 cuft
Drainage area	= 6.600 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

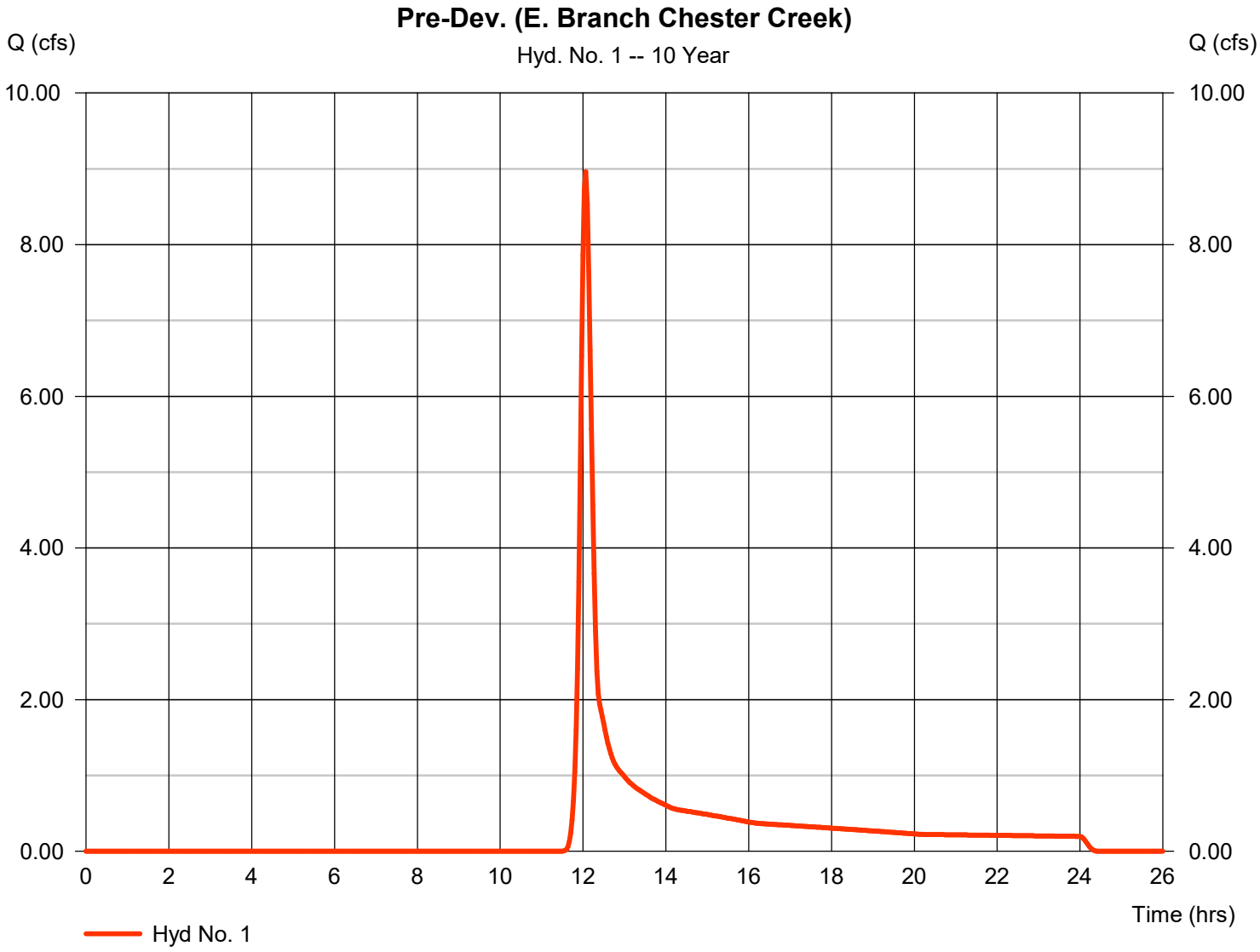
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.961 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 27,703 cuft
Drainage area	= 6.600 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



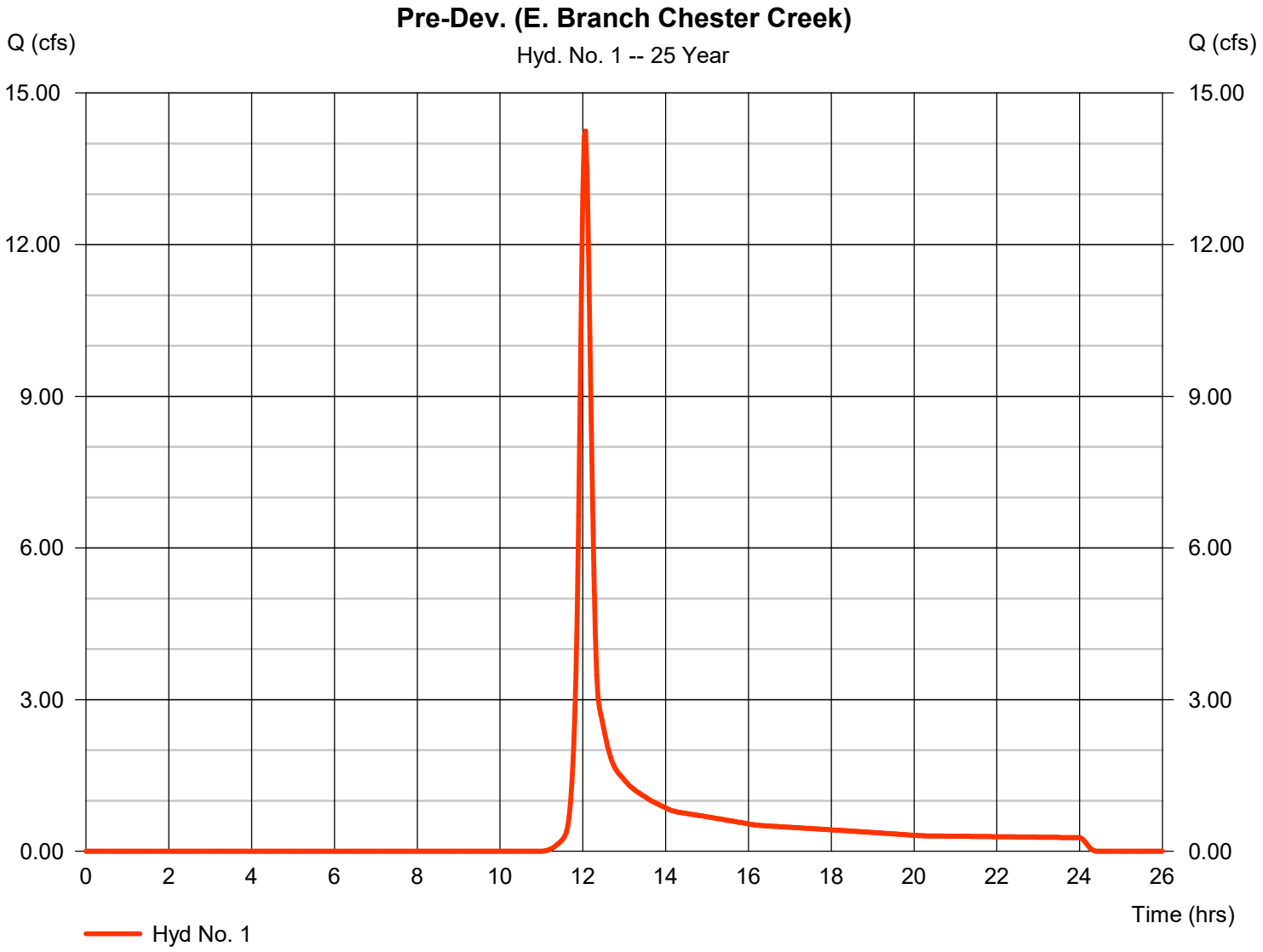
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	= SCS Runoff	Peak discharge	= 14.25 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 42,010 cuft
Drainage area	= 6.600 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 5.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

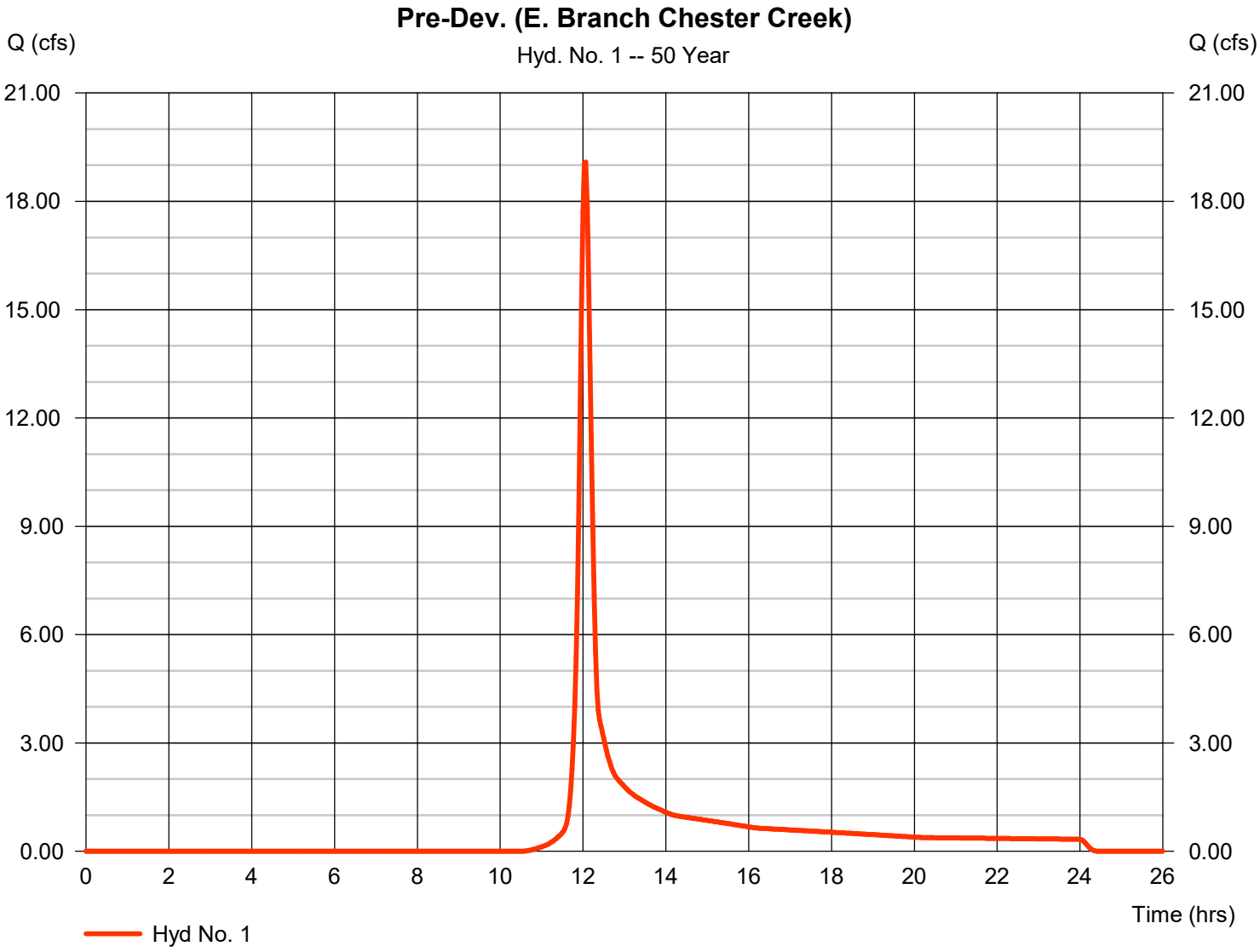


Hydrograph Report

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	=	SCS Runoff	Peak discharge	=	19.09 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	55,262 cuft
Drainage area	=	6.600 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



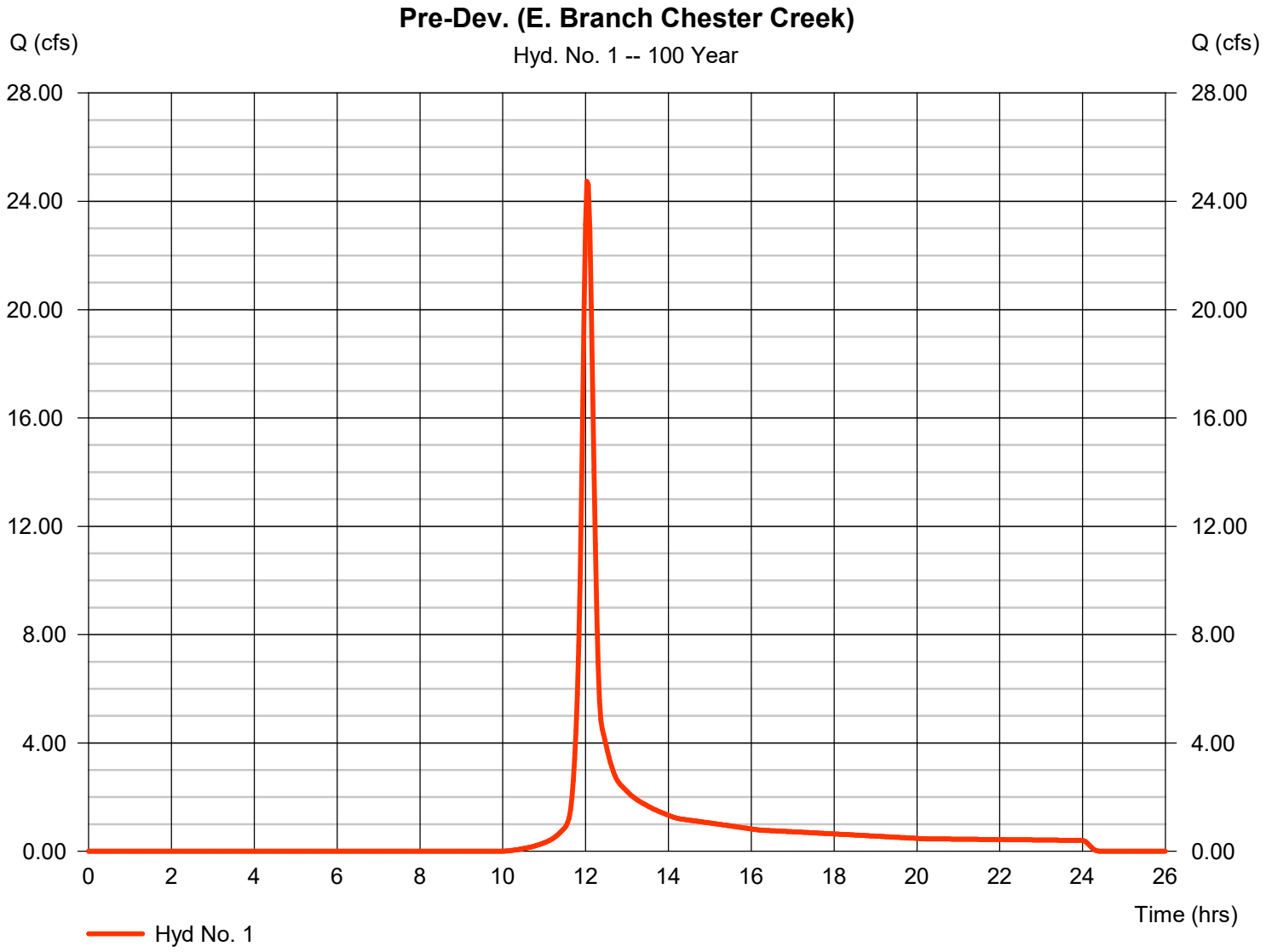
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 1

Pre-Dev. (E. Branch Chester Creek)

Hydrograph type	= SCS Runoff	Peak discharge	= 24.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 70,585 cuft
Drainage area	= 6.600 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



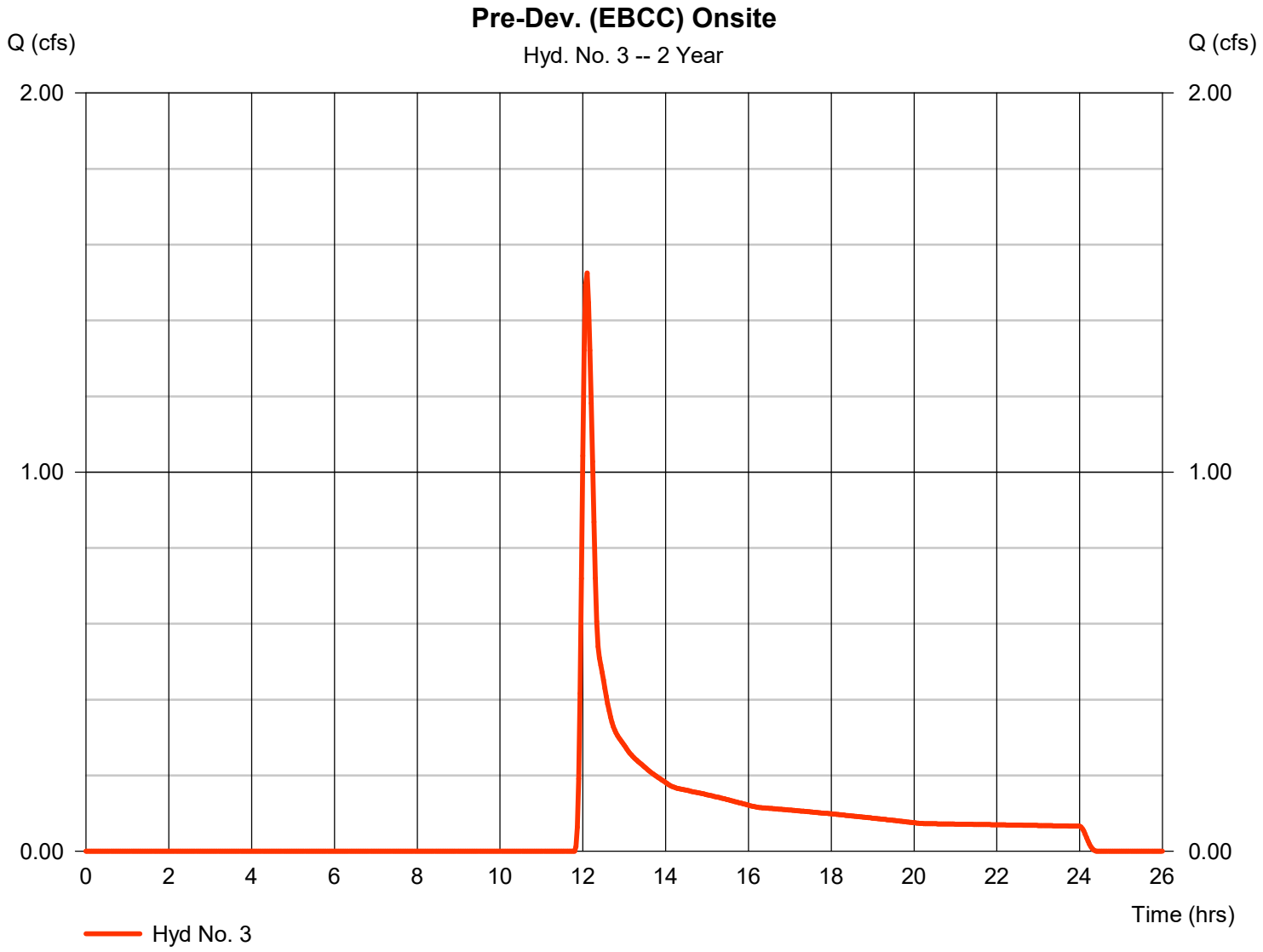
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.525 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	6,891 cuft
Drainage area	=	4.910 ac	Curve number	=	59
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



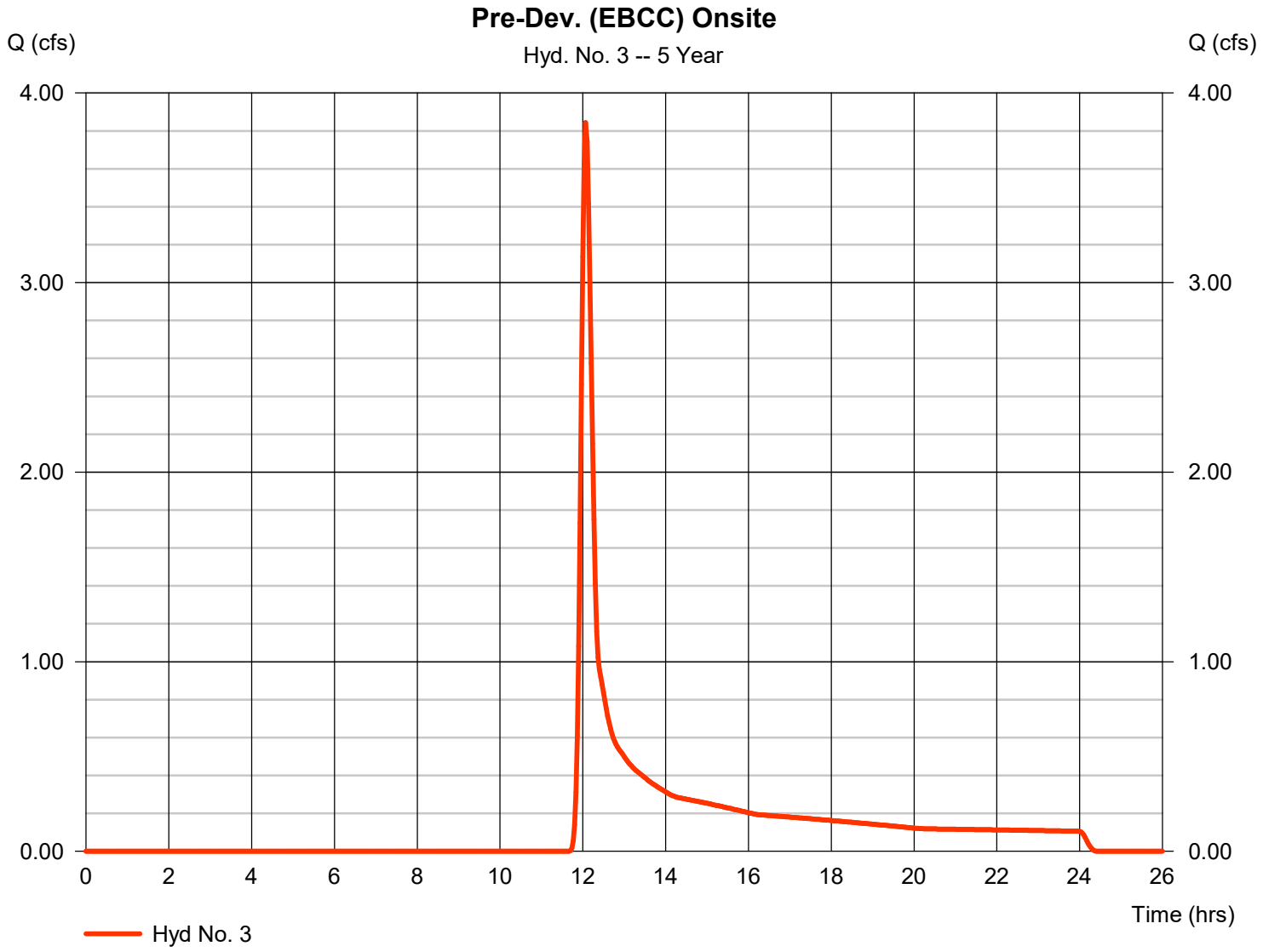
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	= SCS Runoff	Peak discharge	= 3.844 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 13,214 cuft
Drainage area	= 4.910 ac	Curve number	= 59
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

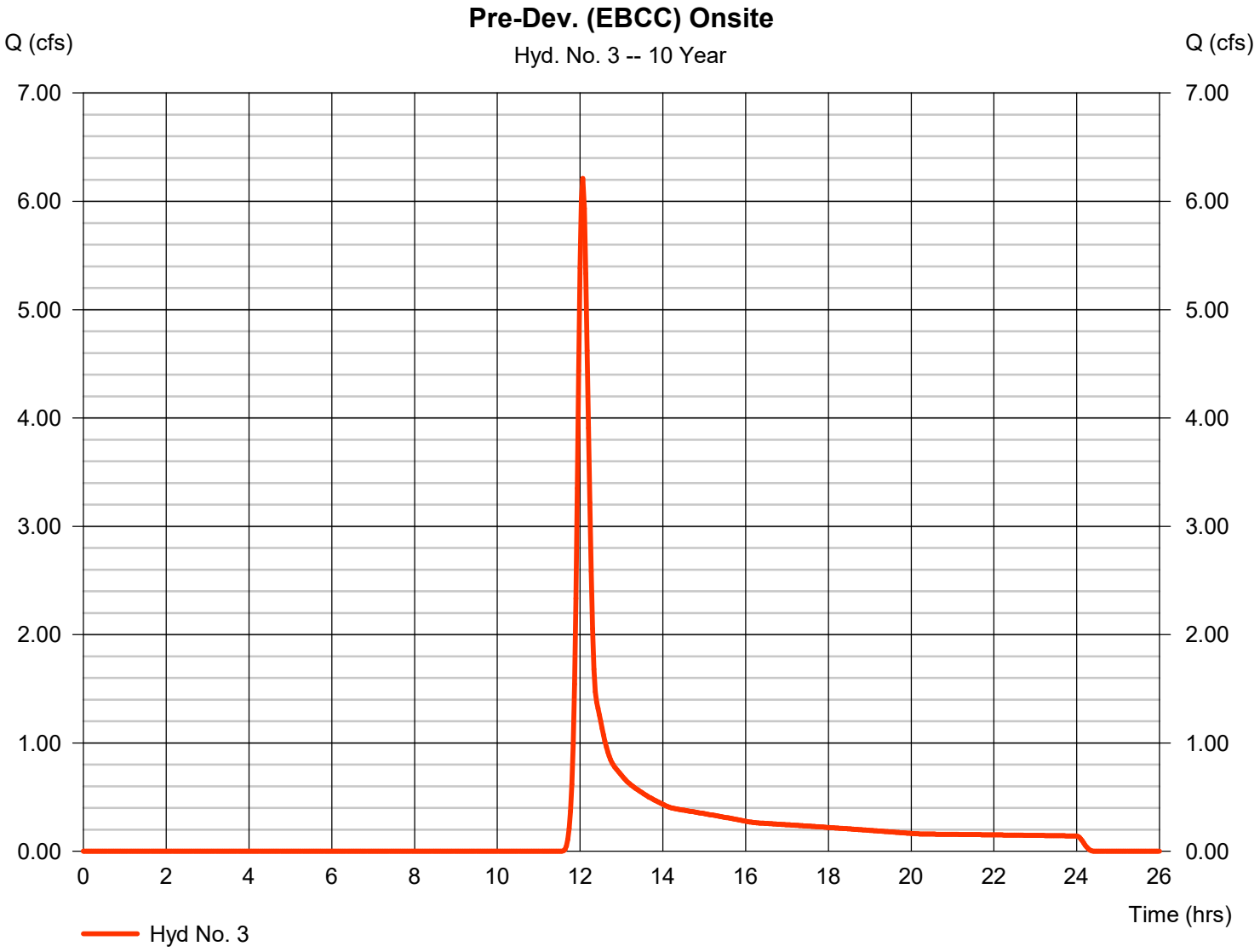


Hydrograph Report

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	= SCS Runoff	Peak discharge	= 6.212 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 19,508 cuft
Drainage area	= 4.910 ac	Curve number	= 59
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



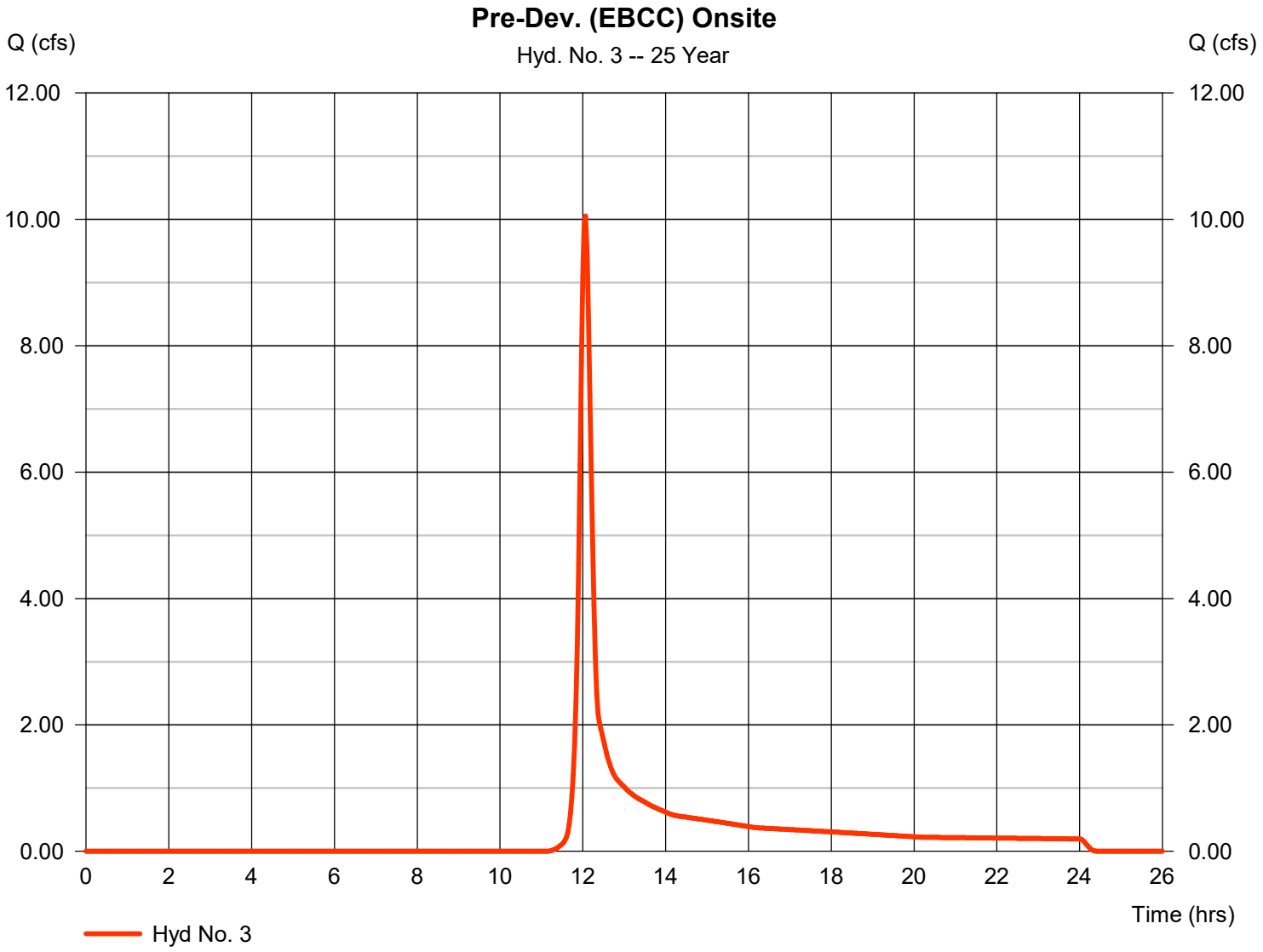
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	= SCS Runoff	Peak discharge	= 10.05 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 29,863 cuft
Drainage area	= 4.910 ac	Curve number	= 59
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 5.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



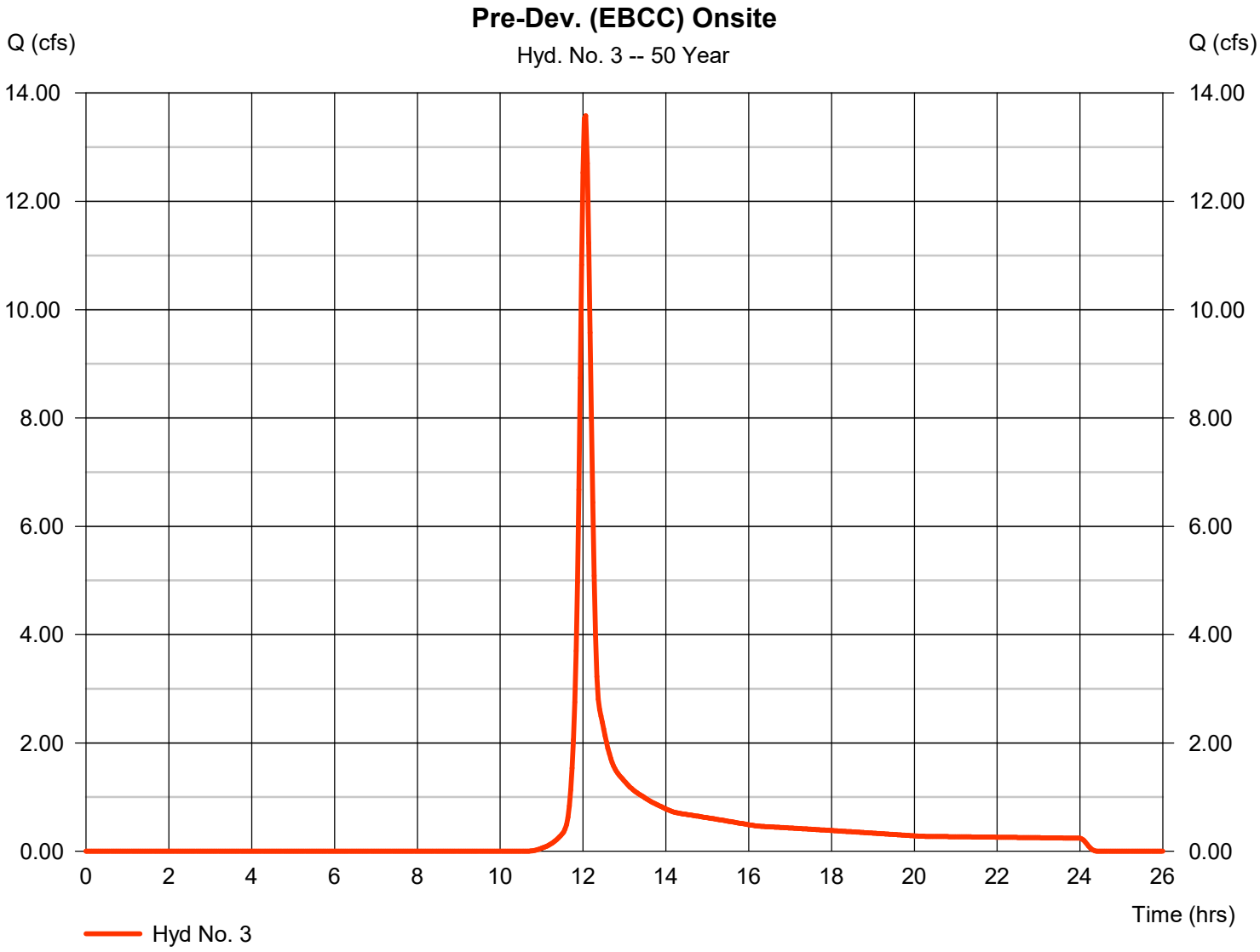
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	= SCS Runoff	Peak discharge	= 13.58 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 39,500 cuft
Drainage area	= 4.910 ac	Curve number	= 59
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 6.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



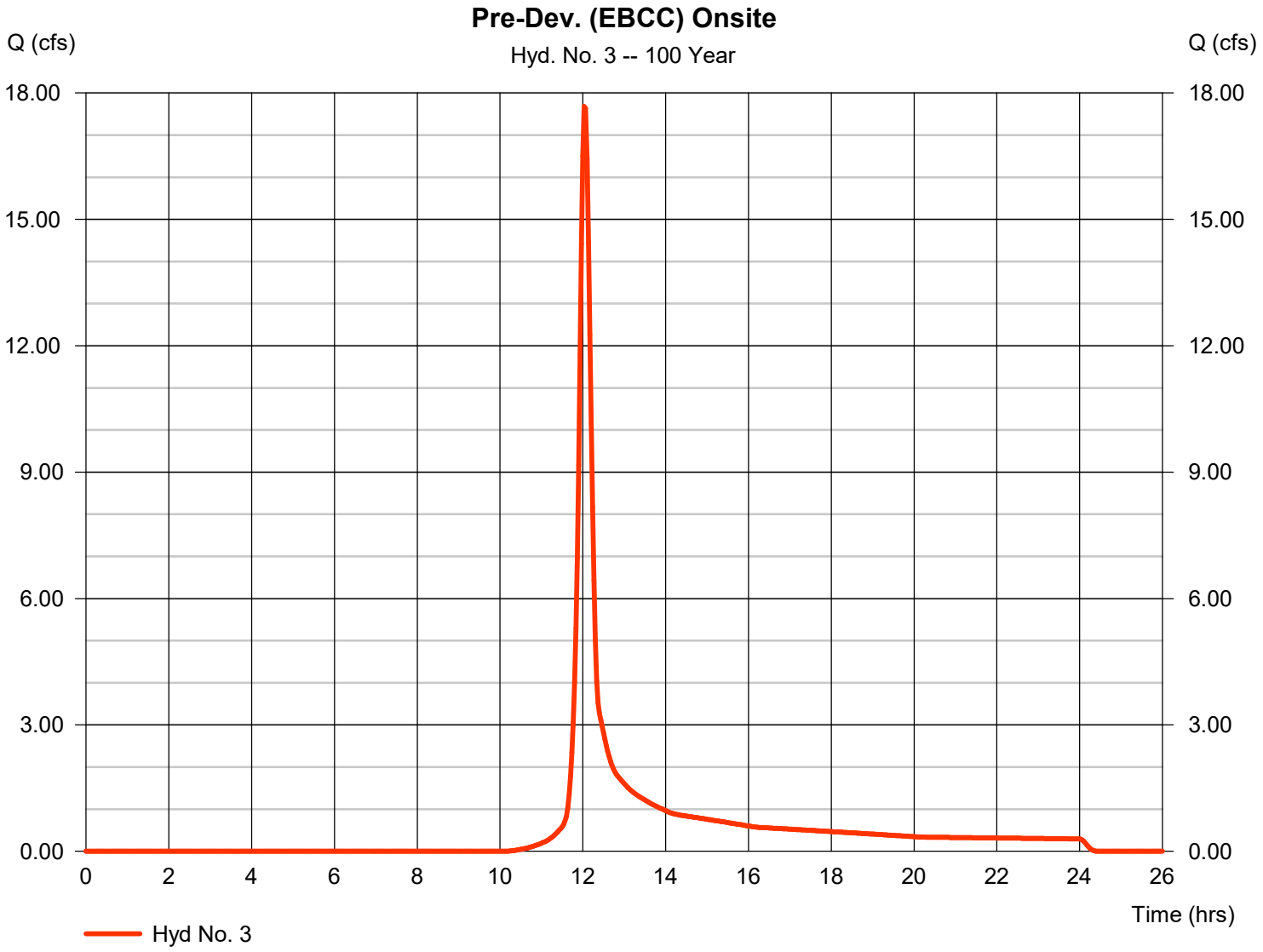
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 09 / 17 / 2023

Hyd. No. 3

Pre-Dev. (EBCC) Onsite

Hydrograph type	= SCS Runoff	Peak discharge	= 17.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 50,679 cuft
Drainage area	= 4.910 ac	Curve number	= 59
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



UNT. TO
EAST BRANCH CHESTER CREEK

ELA SPORT

ATHLETIC FACILITIES DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

ROJECT: The Westtown School - Oak Lane Project
CATION: Westtown Township
COUNTY: Chester

	LAND USE	Parking, Other Impervious (60% of total)	40% of Impervious Areas as Meadow	Meadow	Meadow			
	HSG	B	B	B	D			
	"CN" Value	98	58	58	78	Total	Composite	
WATERSHED		Area (ac)				Area (ac.)	'CN' Value	Tc Min.
Unt. to East Branch Chester Creek		0.01	0.00	15.25	2.11	17.37	60	22
Unt. to EBCC Onsite (Reduction Factor)		0.01	0.00	11.53	1.14	12.68	60	22

ELA SPORT
ATHLETIC FACILITIES
DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

SUMMARY - SUBAREAS TIME OF CONCENTRATION PRE-DEVELOPMENT CONDITIONS

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

Time of concentration (Tc) or travel time (Tt)

	overland					Shallow Concentrated					Channel or Pipe								Total	
Watershed	Length L_1 100 ft. max.	Slope S_1	Manning's n	2 yr rainfall	Tc	Flow Path Cover	Length L_2	Slope S_2	Average Velocity	Tt	Channel or Pipe	Flow Area	Wetted Perimeter	Pipe Diameter	Slope S_3	Manning's n	Length L_3	Tt	Σ Tc	
	ft.	ft./ft.	n	in.	Min.	U/P	ft.	ft./ft.	ft./s	Min.	C/P	sq.ft.	ft.	in.	ft./ft.	n	ft.	Min.	Min.	Hrs.
B	100	0.010	0.24	3.26	18.7				0	0.0		0.00	0.00					0.0		
					0	U	293	0.010	1.6	3.1		0.00	0.00					0.0		
					0	U	108	0.140	6	0.3		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
												0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					18.7					3.4								0	**22**	0.37

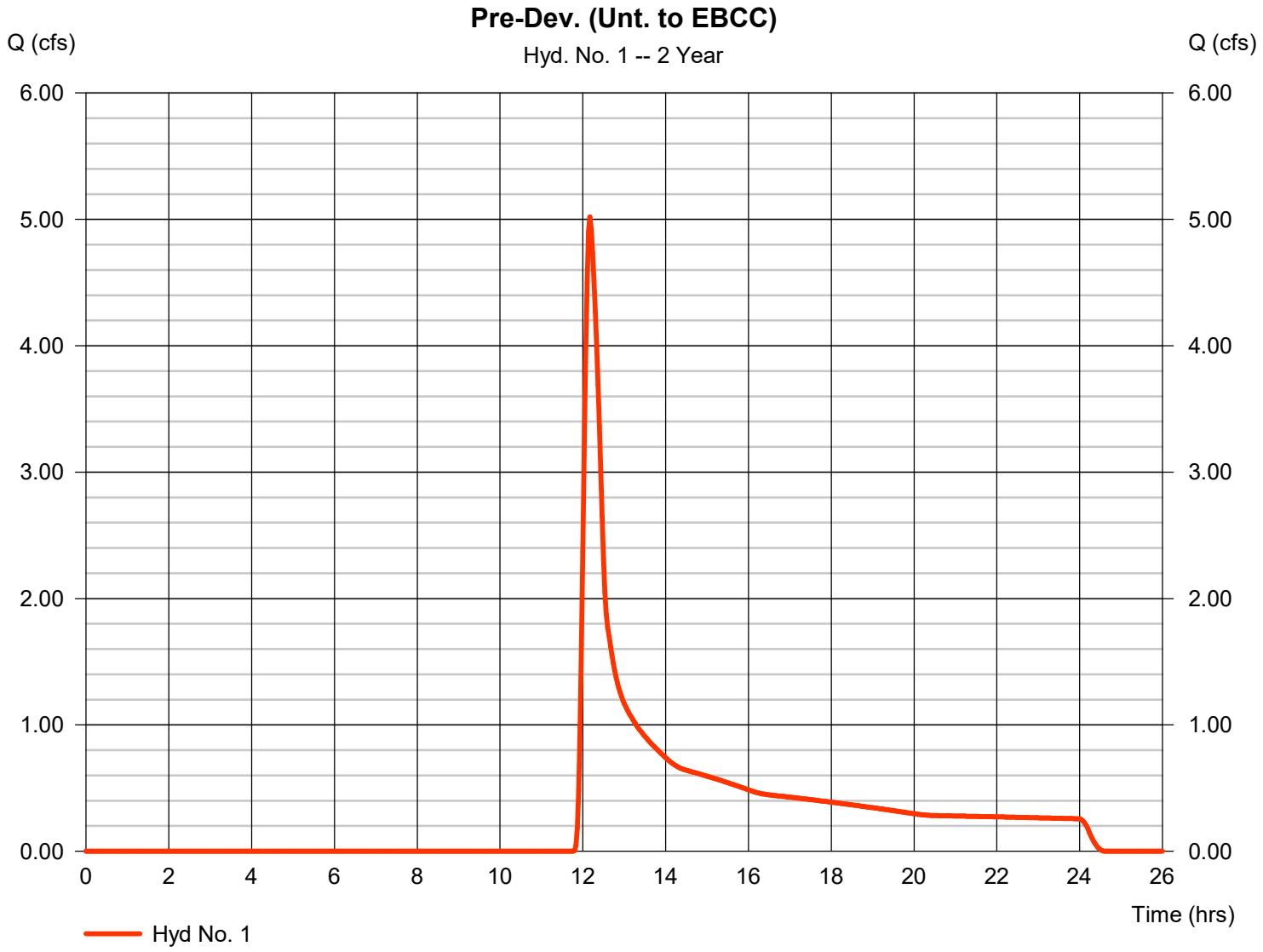
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	= SCS Runoff	Peak discharge	= 5.020 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 27,714 cuft
Drainage area	= 17.370 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 3.26 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



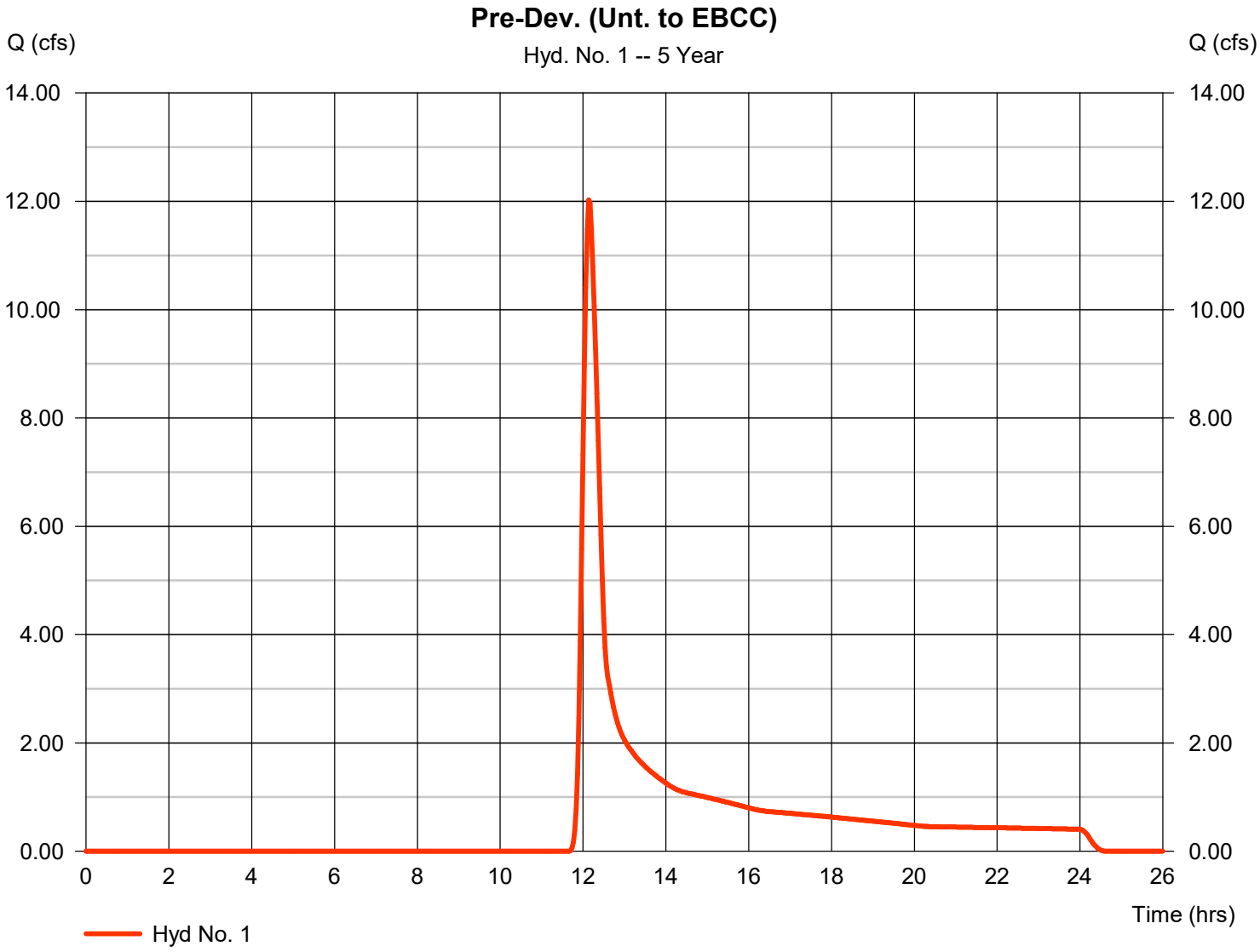
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	= SCS Runoff	Peak discharge	= 12.03 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 52,072 cuft
Drainage area	= 17.370 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 4.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



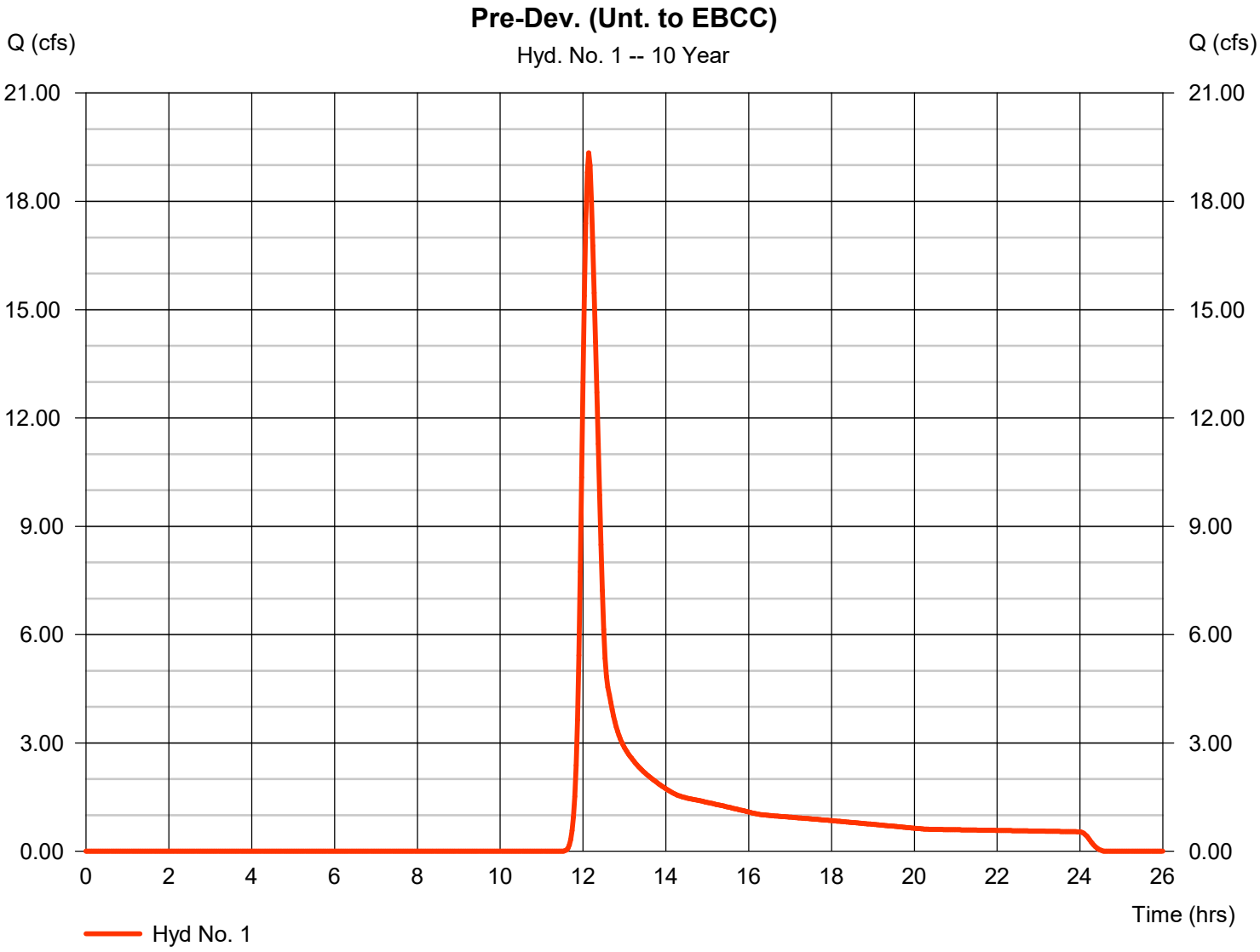
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	= SCS Runoff	Peak discharge	= 19.34 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 76,114 cuft
Drainage area	= 17.370 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



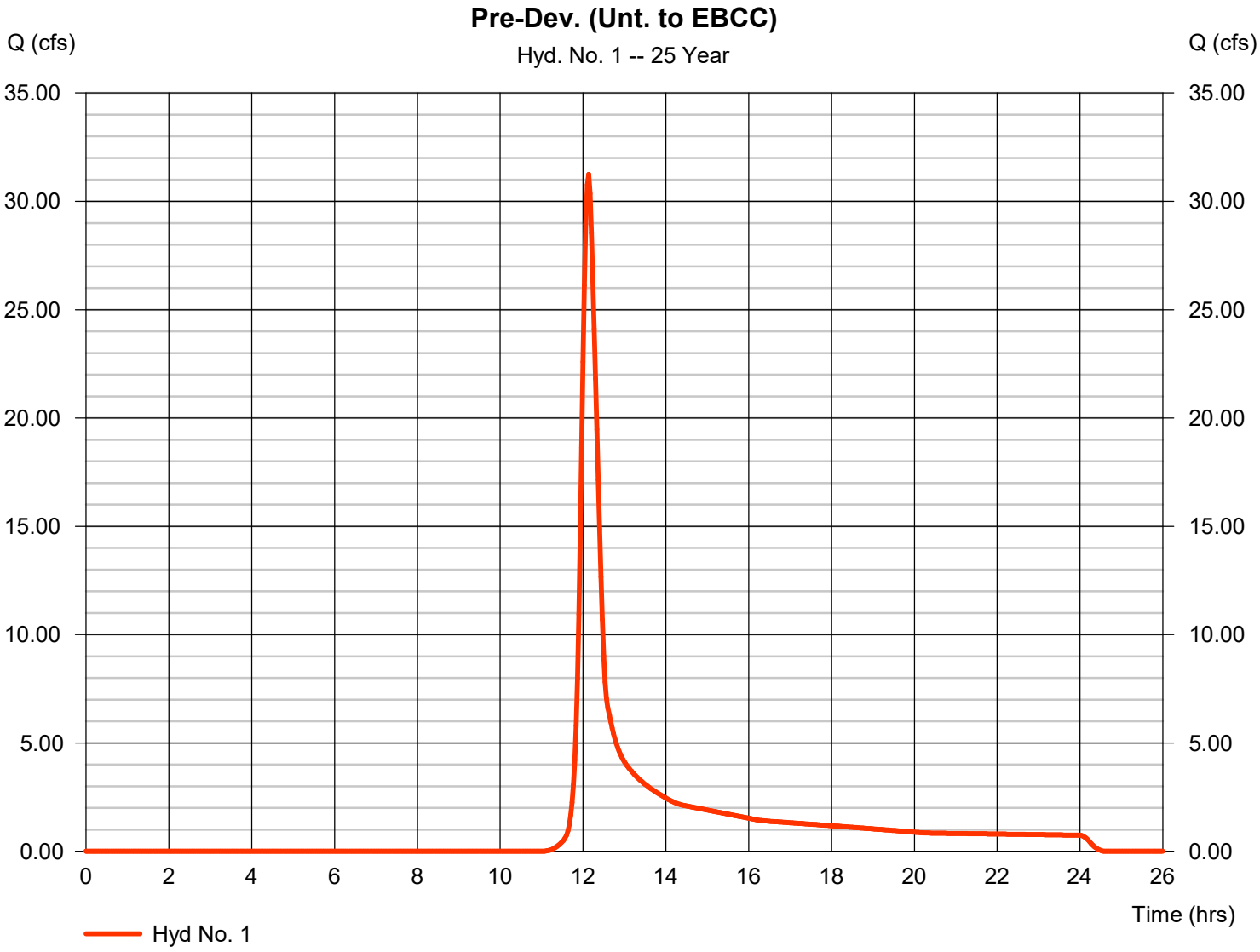
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	= SCS Runoff	Peak discharge	= 31.25 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 115,422 cuft
Drainage area	= 17.370 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 5.81 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



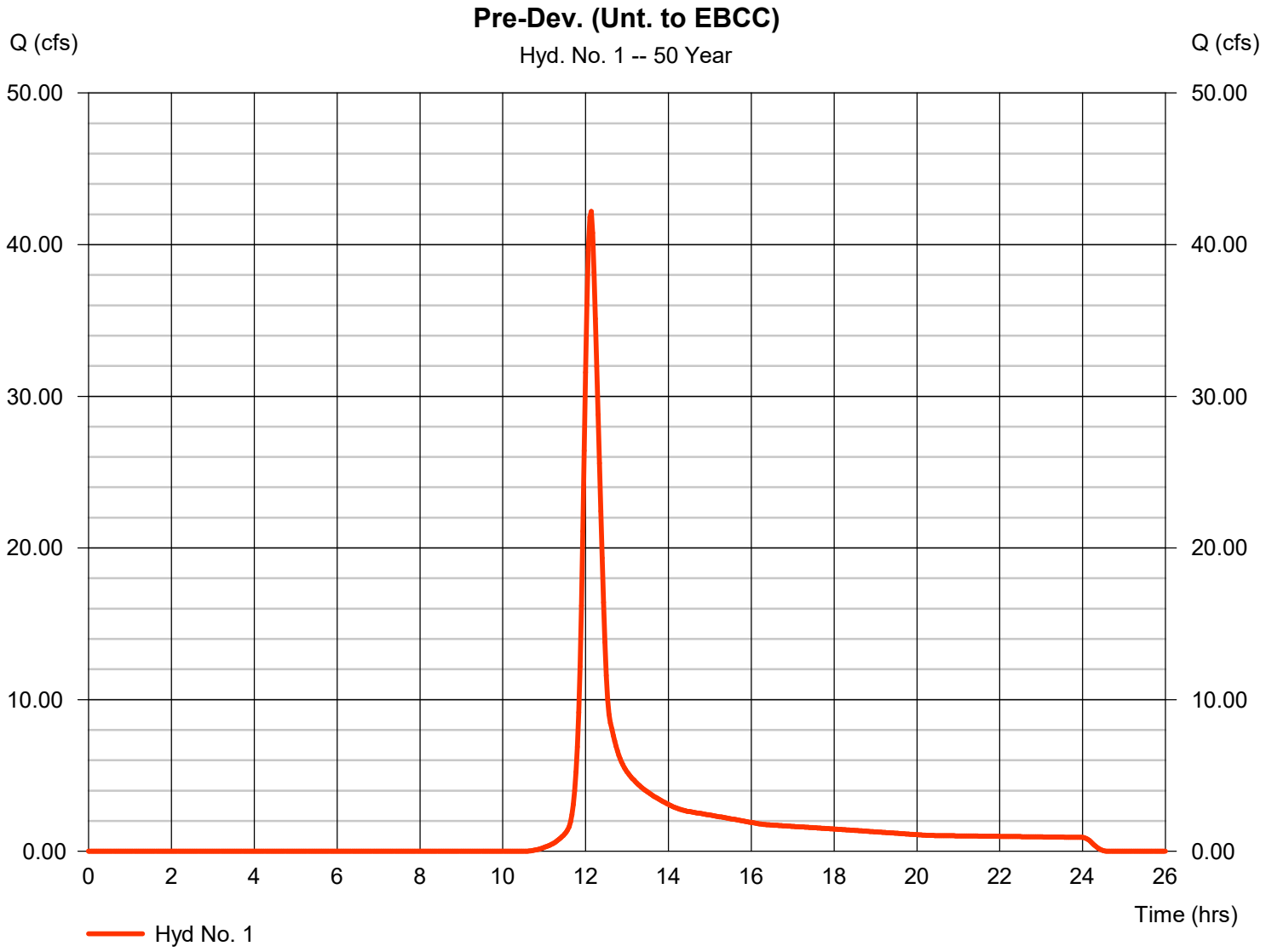
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	= SCS Runoff	Peak discharge	= 42.19 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 151,832 cuft
Drainage area	= 17.370 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 6.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



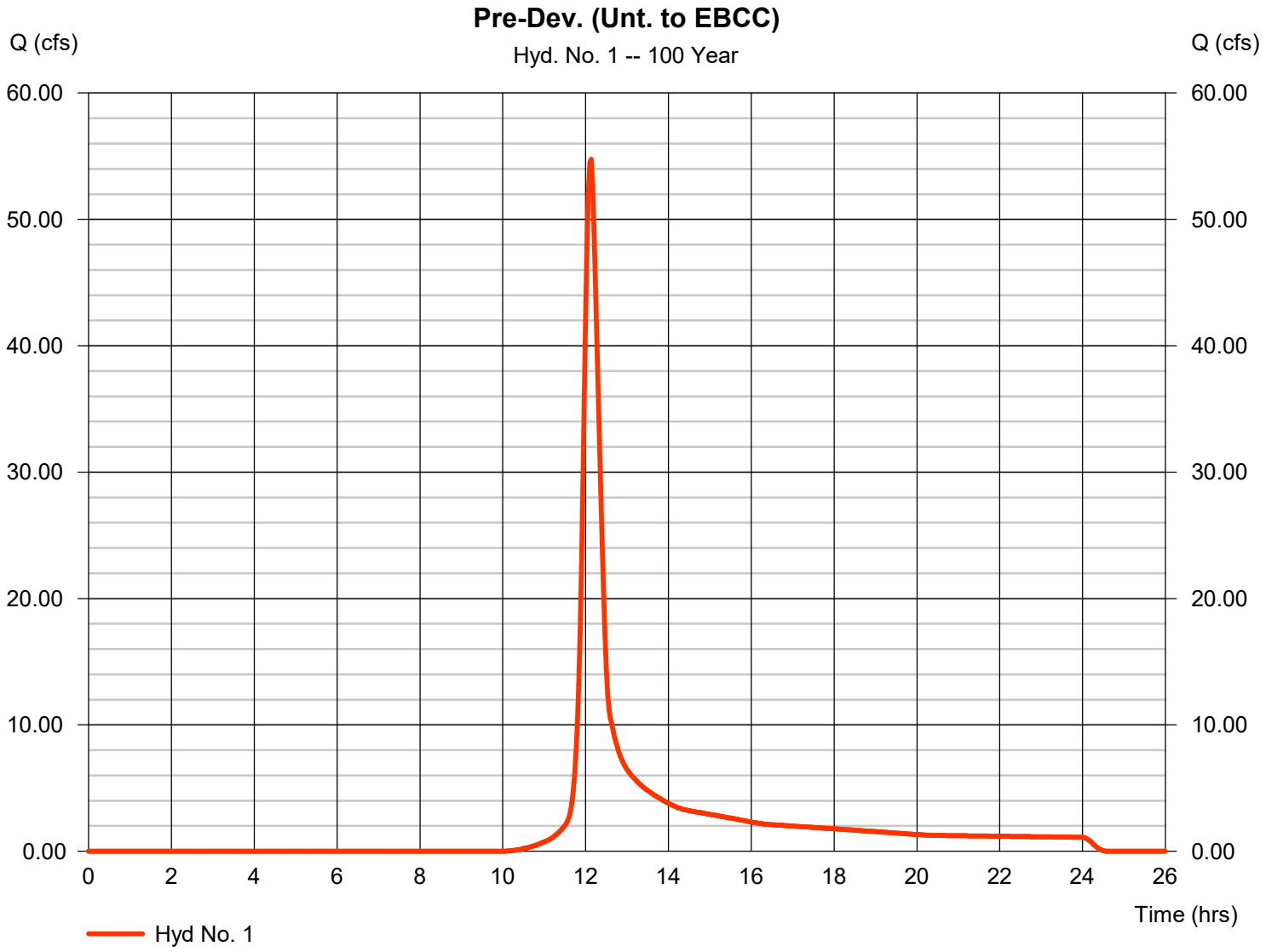
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 1

Pre-Dev. (Unt. to EBCC)

Hydrograph type	=	SCS Runoff	Peak discharge	=	54.74 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	193,933 cuft
Drainage area	=	17.370 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



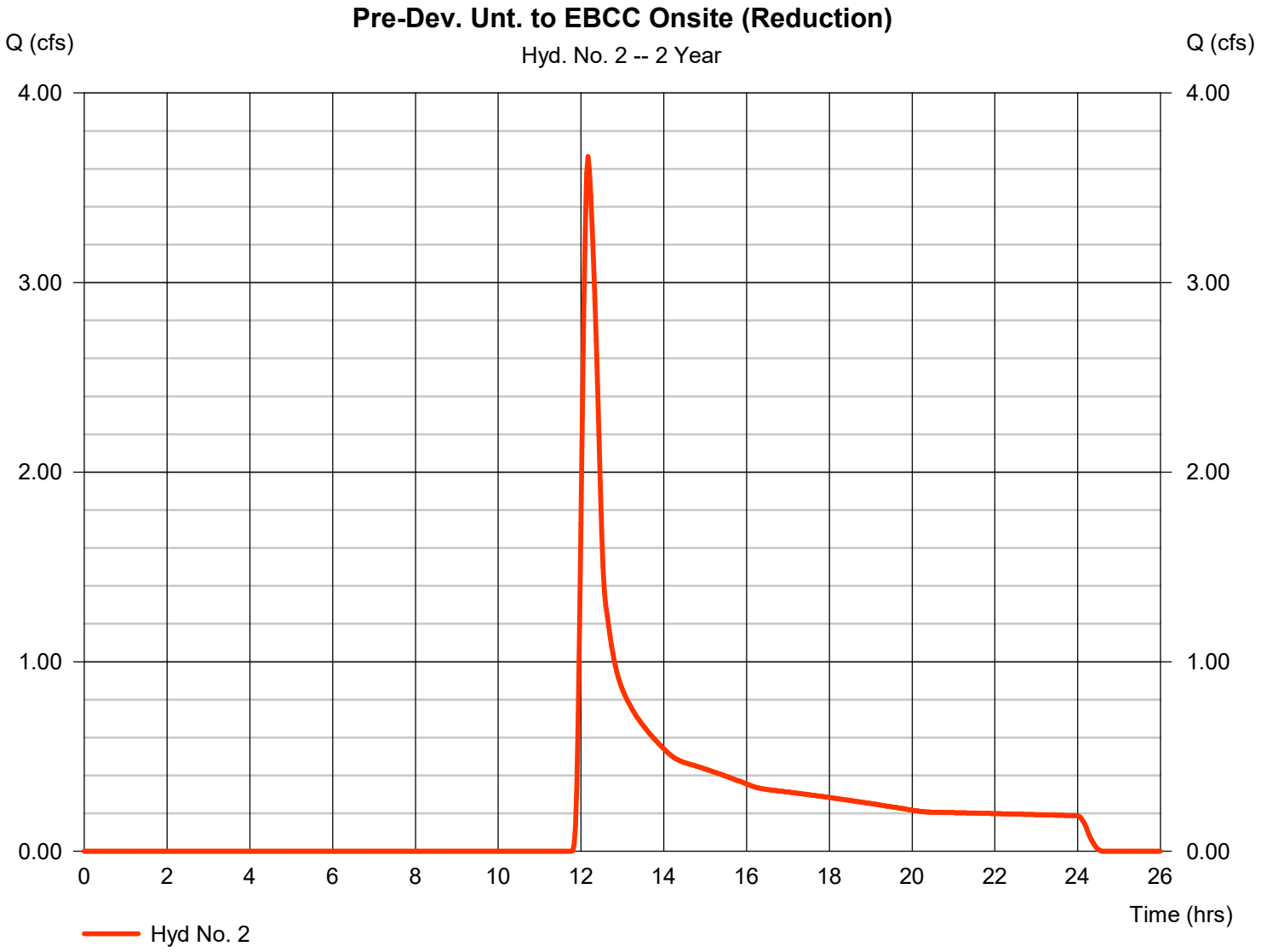
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	= SCS Runoff	Peak discharge	= 3.664 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 20,231 cuft
Drainage area	= 12.680 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 3.26 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



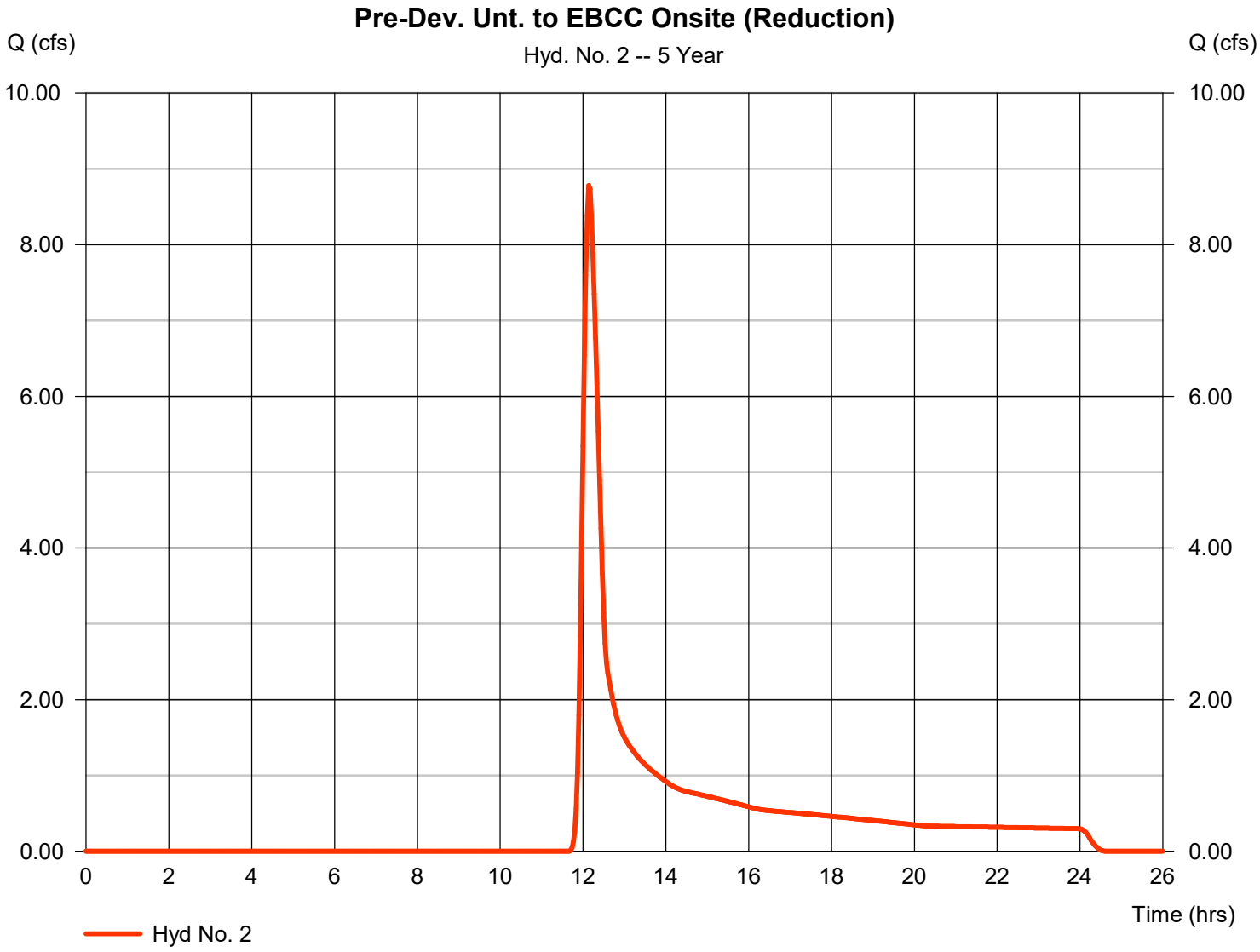
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	= SCS Runoff	Peak discharge	= 8.779 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 38,012 cuft
Drainage area	= 12.680 ac	Curve number	= 60
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 22.00 min
Total precip.	= 4.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



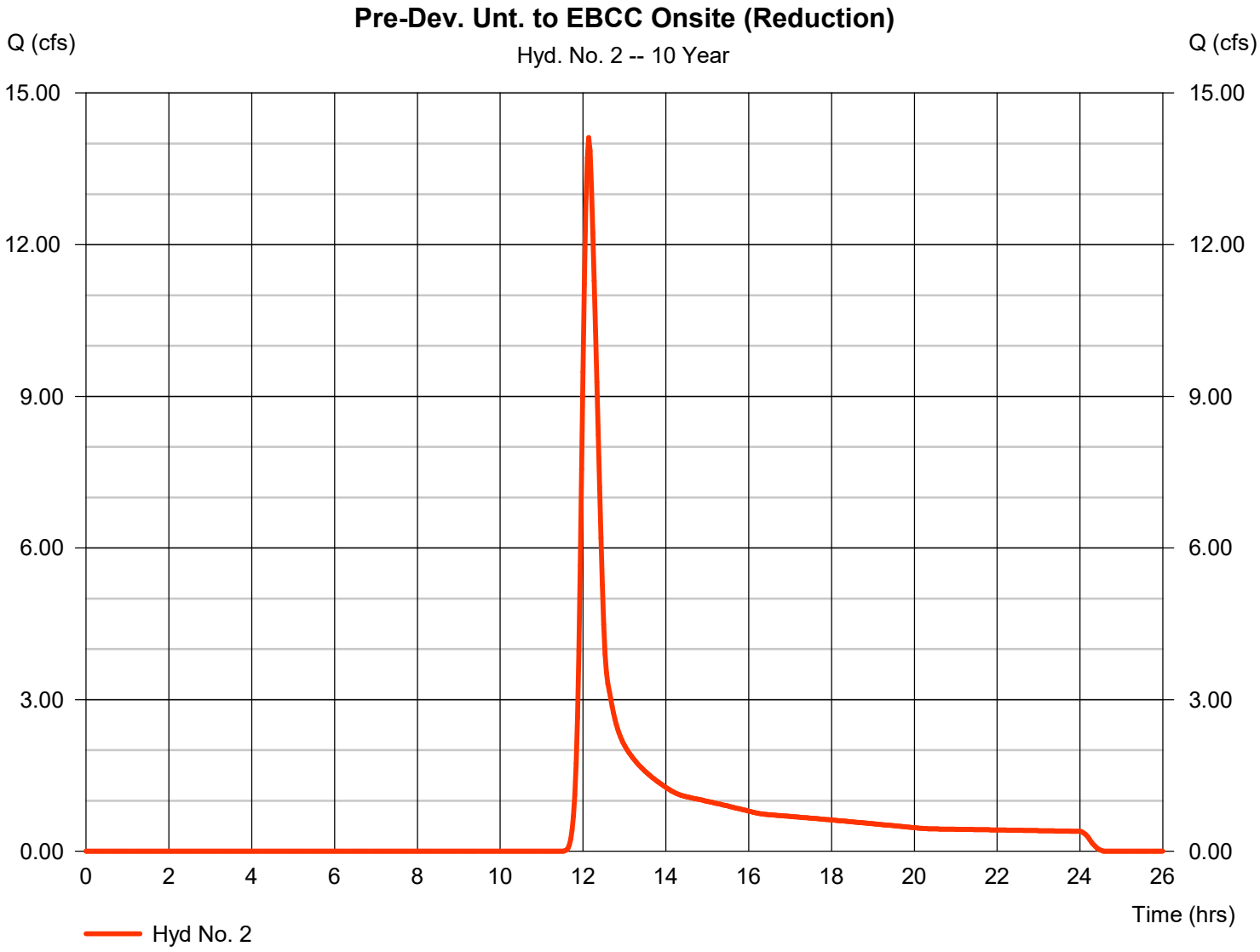
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.12 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	55,563 cuft
Drainage area	=	12.680 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	4.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



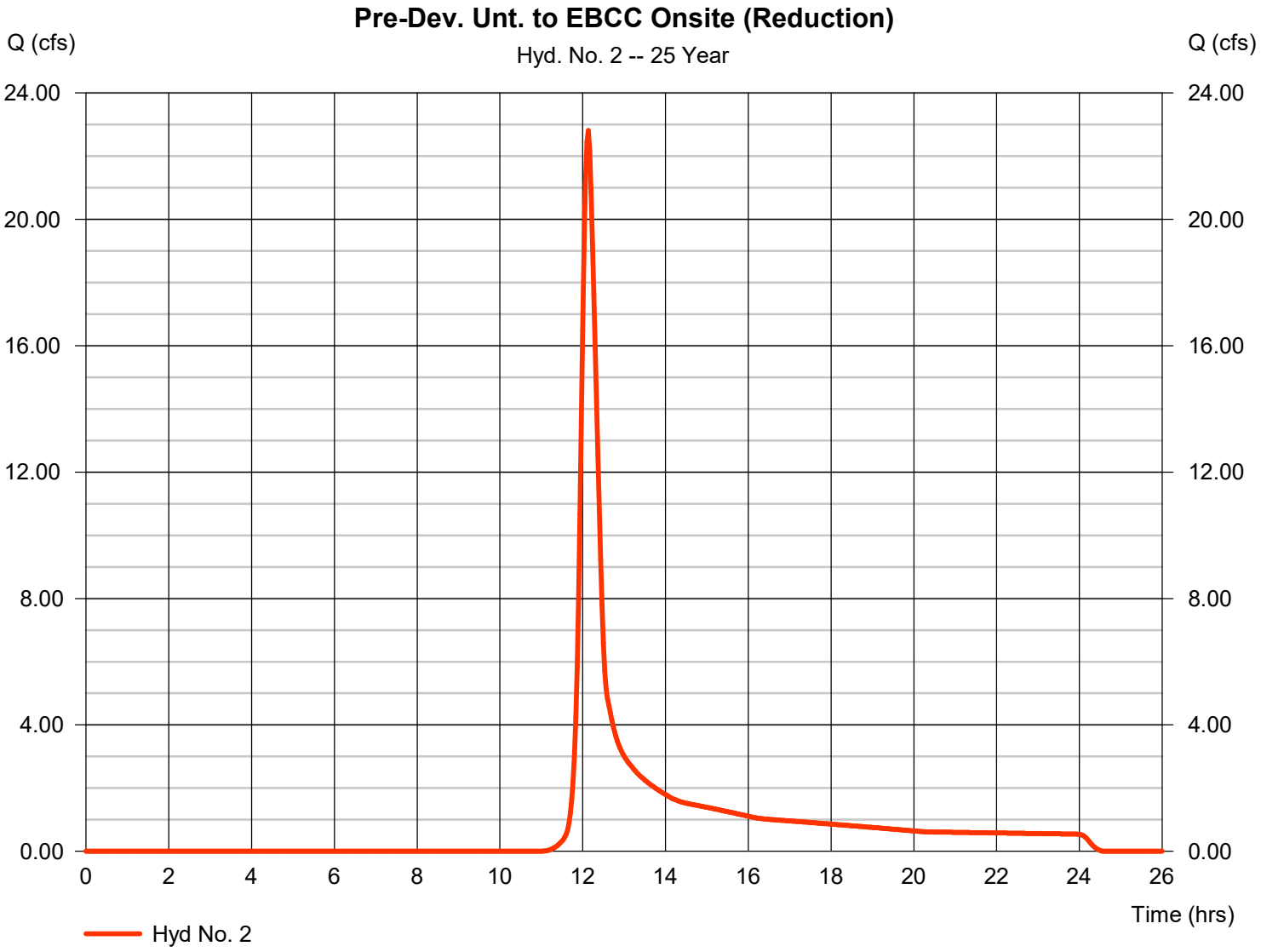
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.81 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	84,257 cuft
Drainage area	=	12.680 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



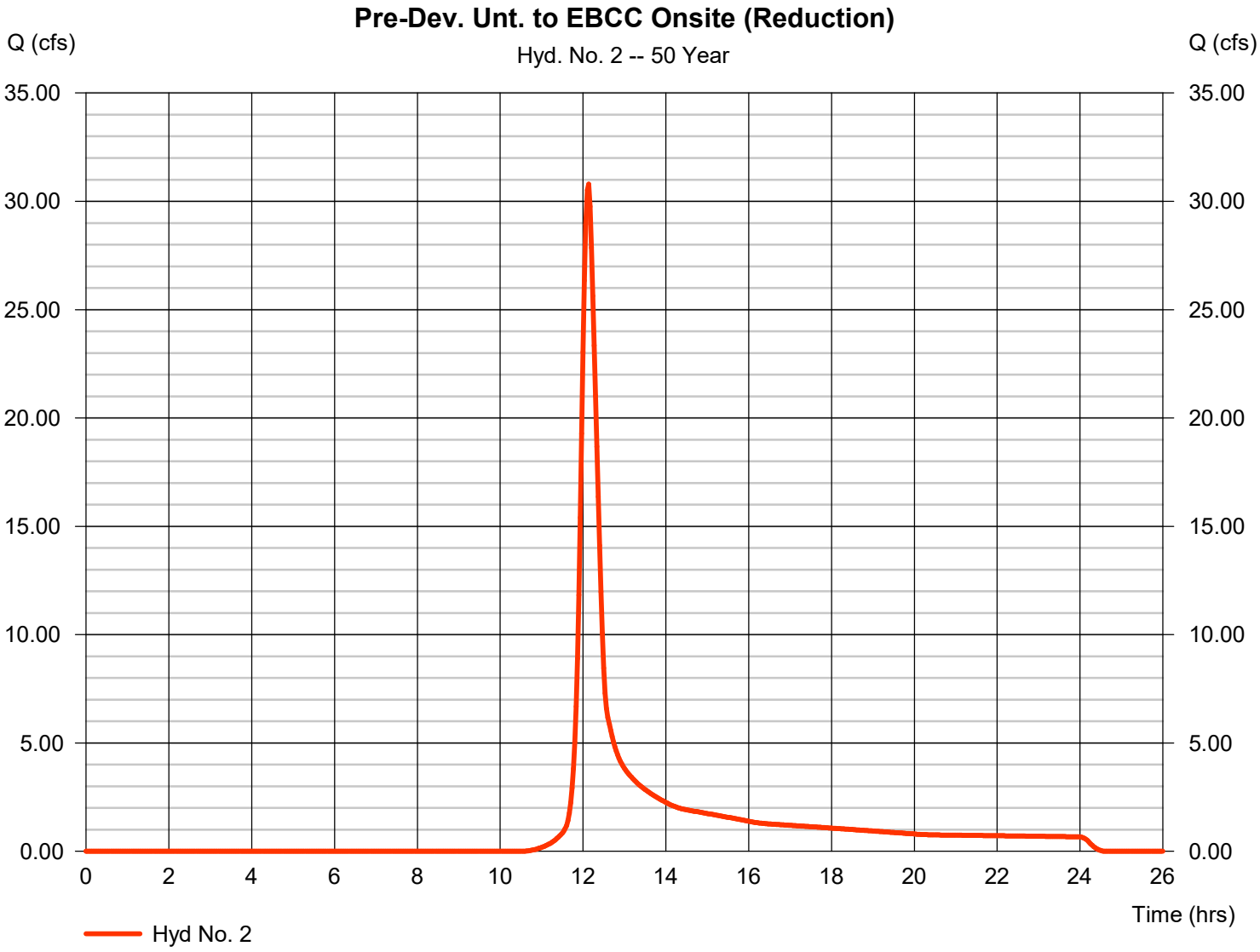
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	=	SCS Runoff	Peak discharge	=	30.80 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	110,837 cuft
Drainage area	=	12.680 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



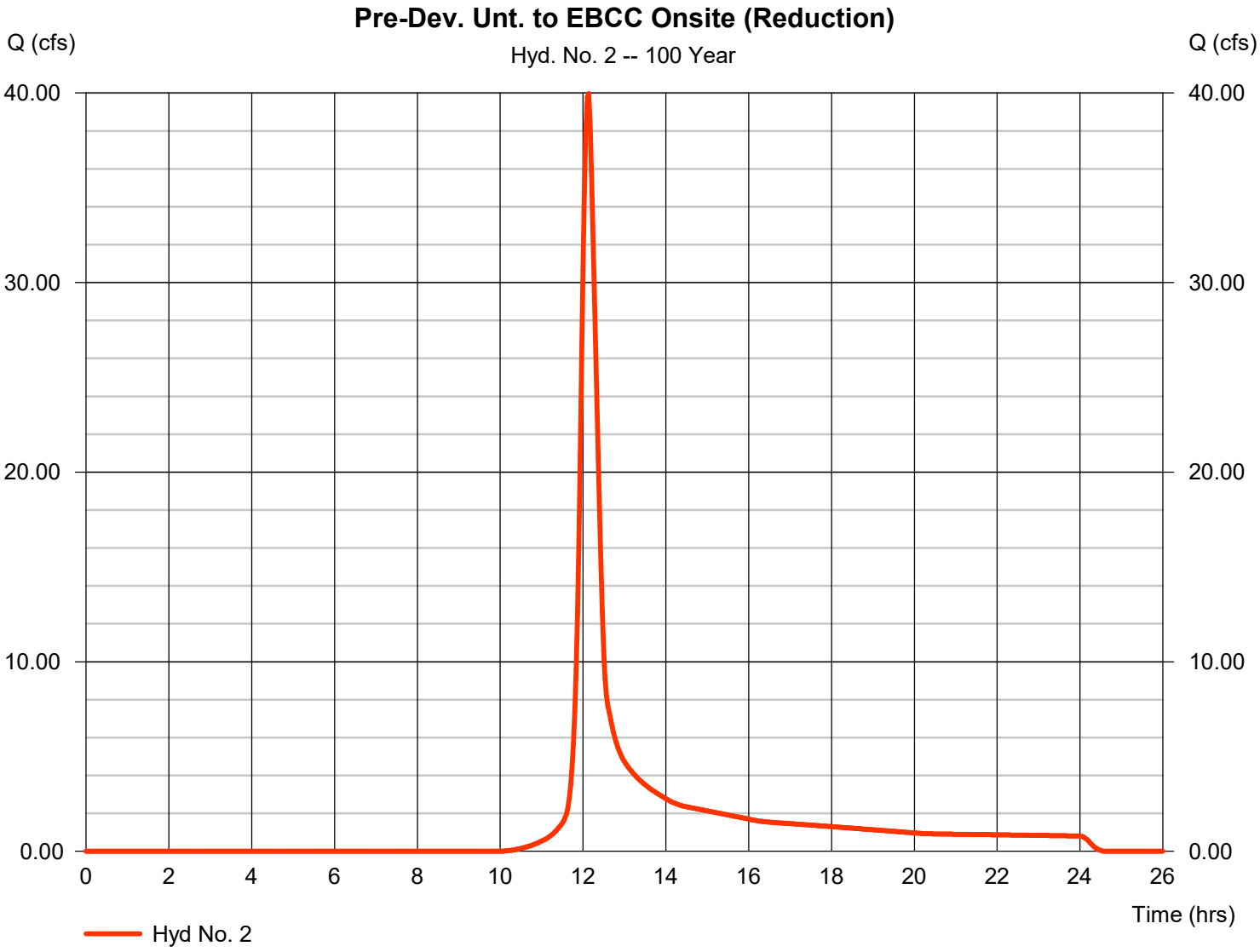
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 2

Pre-Dev. Unt. to EBCC Onsite (Reduction)

Hydrograph type	=	SCS Runoff	Peak discharge	=	39.96 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	141,570 cuft
Drainage area	=	12.680 ac	Curve number	=	60
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



POST-DEVELOPMENT HYDROLOGY
(EAST BRANCH CHESTER CREEK)

ELA SPORT
ATHLETIC FACILITIES DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

NRCS (SCS) TR-55- WATERSHED WEIGHTED CURVE NUMBER
POST-DEVELOPMENT SUMMARY

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

	LAND USE	Parking, Other Impervious (Disturbed Area)	Parking, Other Impervious (Undisturbed Area)	Open Space (Disturbed Area)	Open Space (Undsturbed Area)	Open Space (Disturbed Area)	Open Space (Undsturbed Area)			
	HSG	B	B	B	B	D	D	Total Area (ac.)	Composite 'CN' Value	Tc Min.
	"CN" Value	98	98	61	61	80	80			
WATERSHED		Area (ac)								
East Branch Chester Creek Undetained		0.12	0.03	1.10	0.03	0.00	0.00	1.27	65	5
BMP 1		1.07	0.16	2.29	1.47	0.00	0.00	4.99	70	13

ELA SPORT
ATHLETIC FACILITIES
DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

SUMMARY - SUBAREAS TIME OF CONCENTRATION PRE-DEVELOPMENT CONDITIONS

PROJECT:	The Westtown School - Oak Lane Project
LOCATION:	Westtown Township
COUNTY:	Chester

Time of concentration (Tc) or travel time (Tt)

NRCS Velocity(Segmental) Method

	overland					Shallow Concentrated					Channel or Pipe								Total	
Sub area	Length L_1 100 ft. max.	Slope S_1	Manning's n	2 yr rainfall	Tc	Flow Path Cover	Length L_2	Slope S_2	Average Velocity	Tt	Channel or Pipe	Flow Area	Wetted Perimeter	Pipe Diameter	Slope S_3	Manning's n	Length L_3	Tt	Σ Tc	
	ft.	ft./ft.	n	in.	Min.	U/P	ft.	ft./ft.	ft./s	Min.	C/P	sq.ft.	ft.	in.	ft./ft.	n	ft.	Min.	Min.	Hrs.
BMP 1	100	0.040	0.24	3.26	11				0	0.0		0.00	0.00					0		
				3.26	0	U	180	0.060	4	0.8		0.00	0.00					0		
				3.26	0	P	153	0.013	2.3	1.1		0.00	0.00					0		
					0	U	40	0.180	6.8	0.1		0.00	0.00					0		
					0	U	65	0.015	2	0.5		0.00	0.00					0.0		
					10.7					2.5								0.0	**13**	0.22

FILE NAME:WESTTOWN-STORM.xlsx - Post_Tc_ (A)

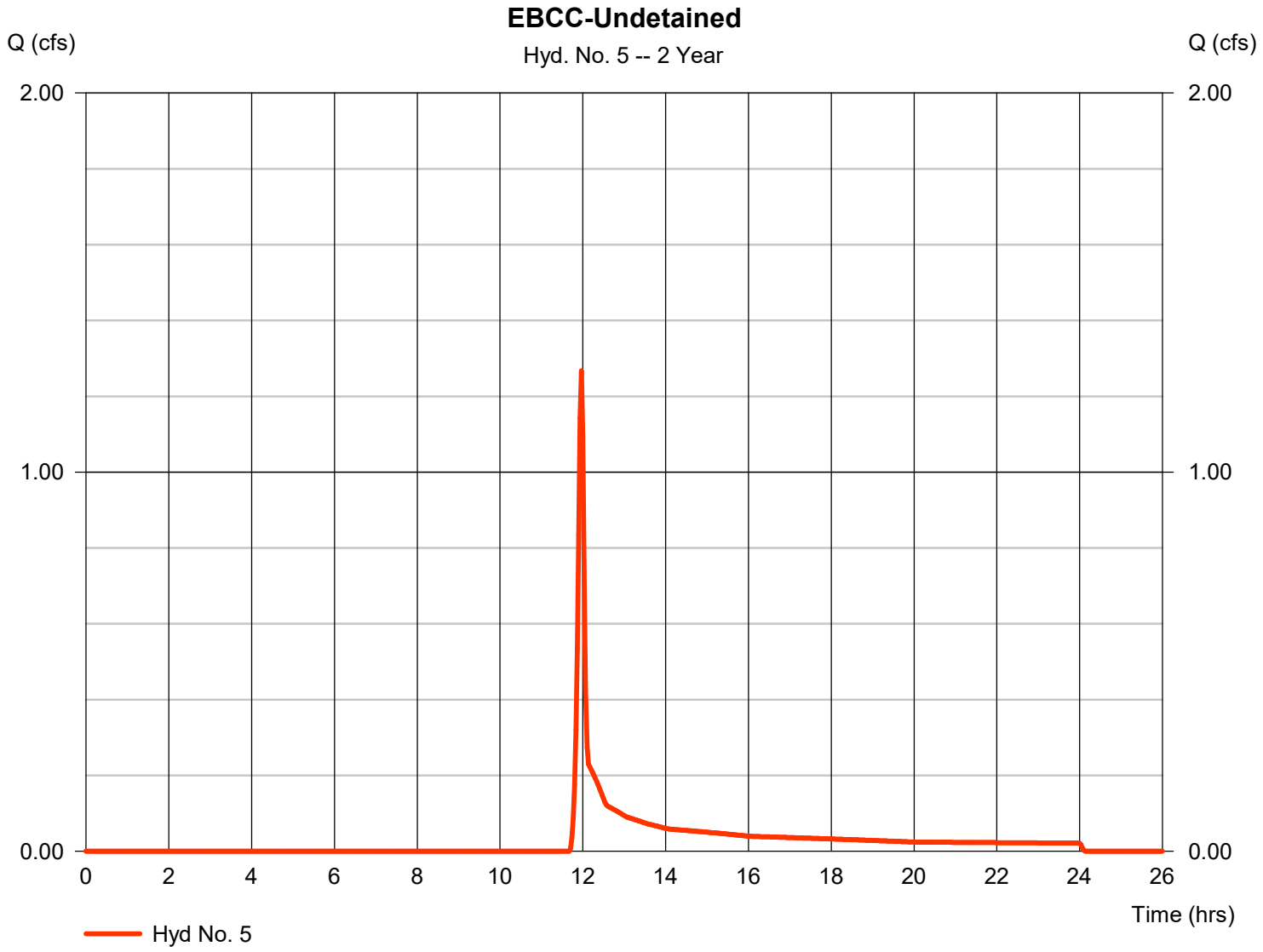
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.267 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	2,722 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



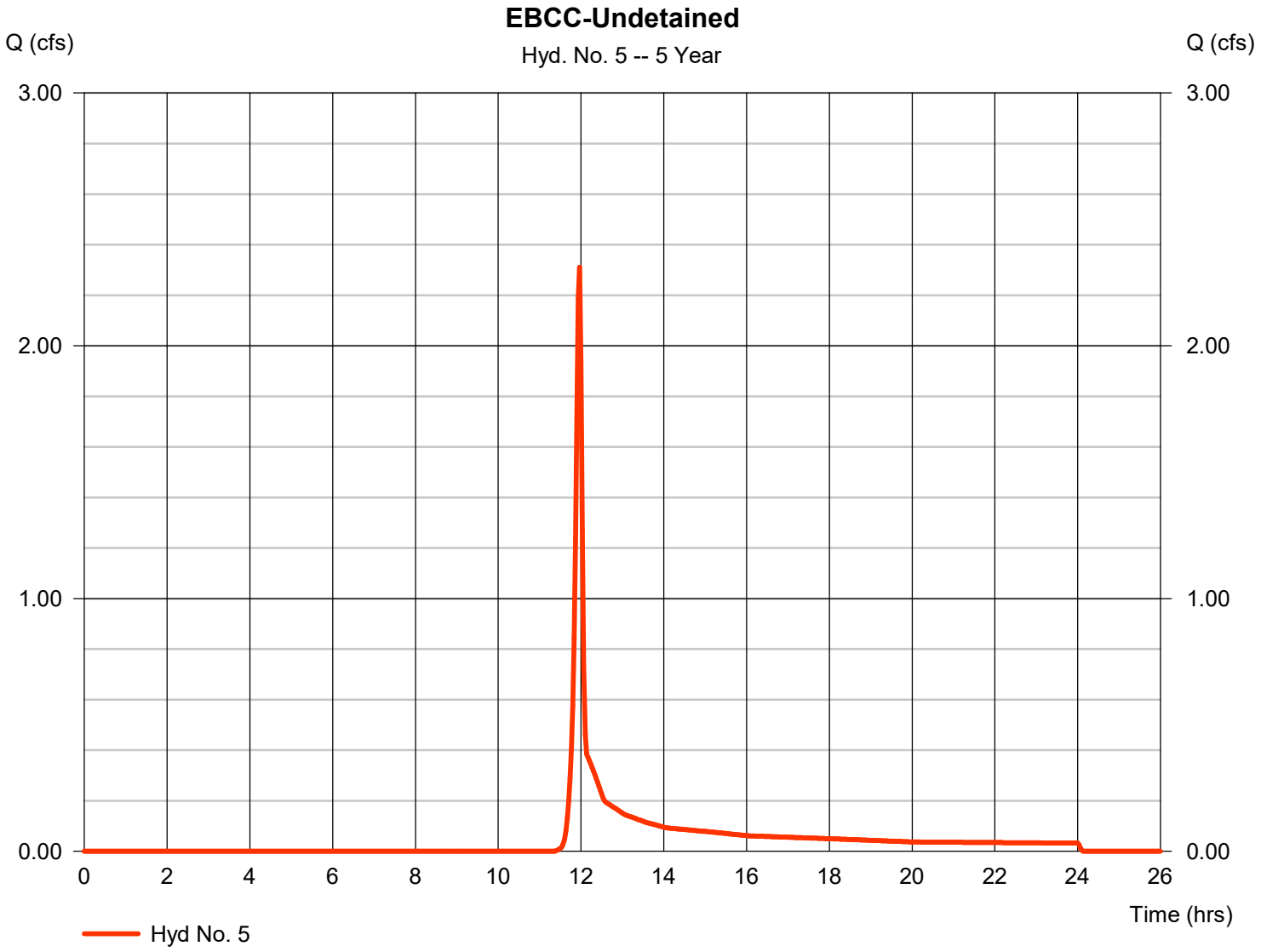
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.311 cfs
Storm frequency	=	5 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	4,698 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



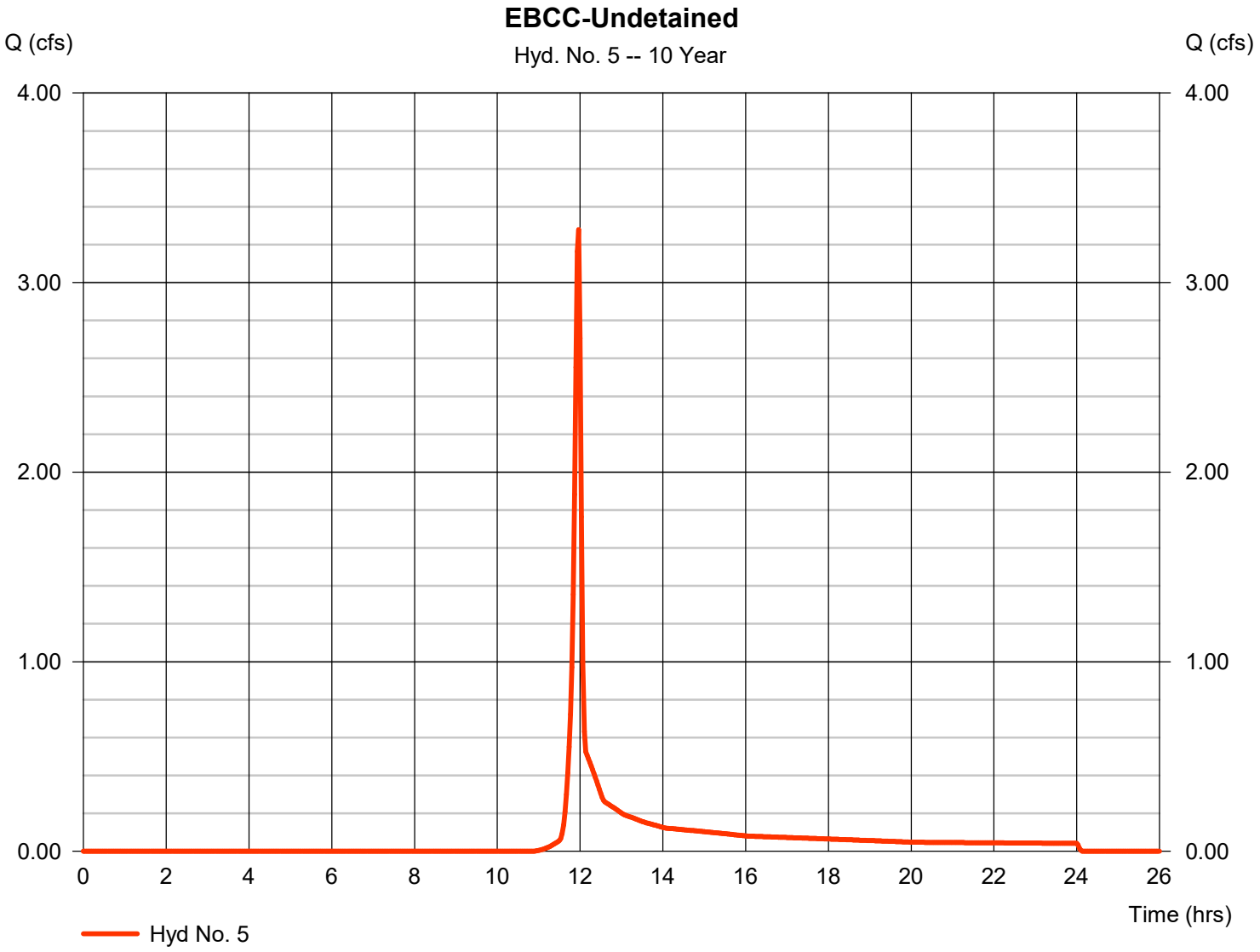
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.279 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	6,578 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



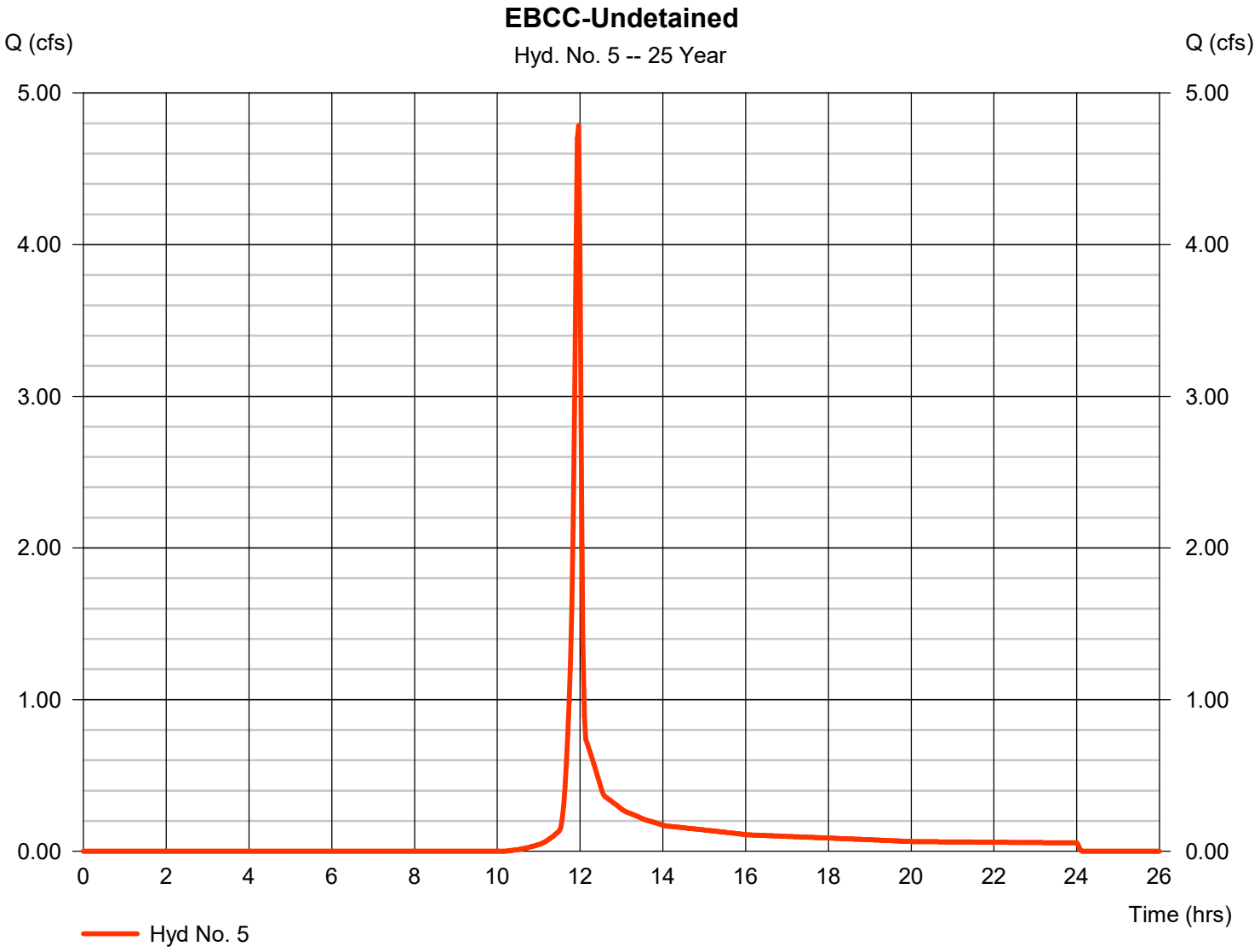
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.785 cfs
Storm frequency	=	25 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	9,569 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



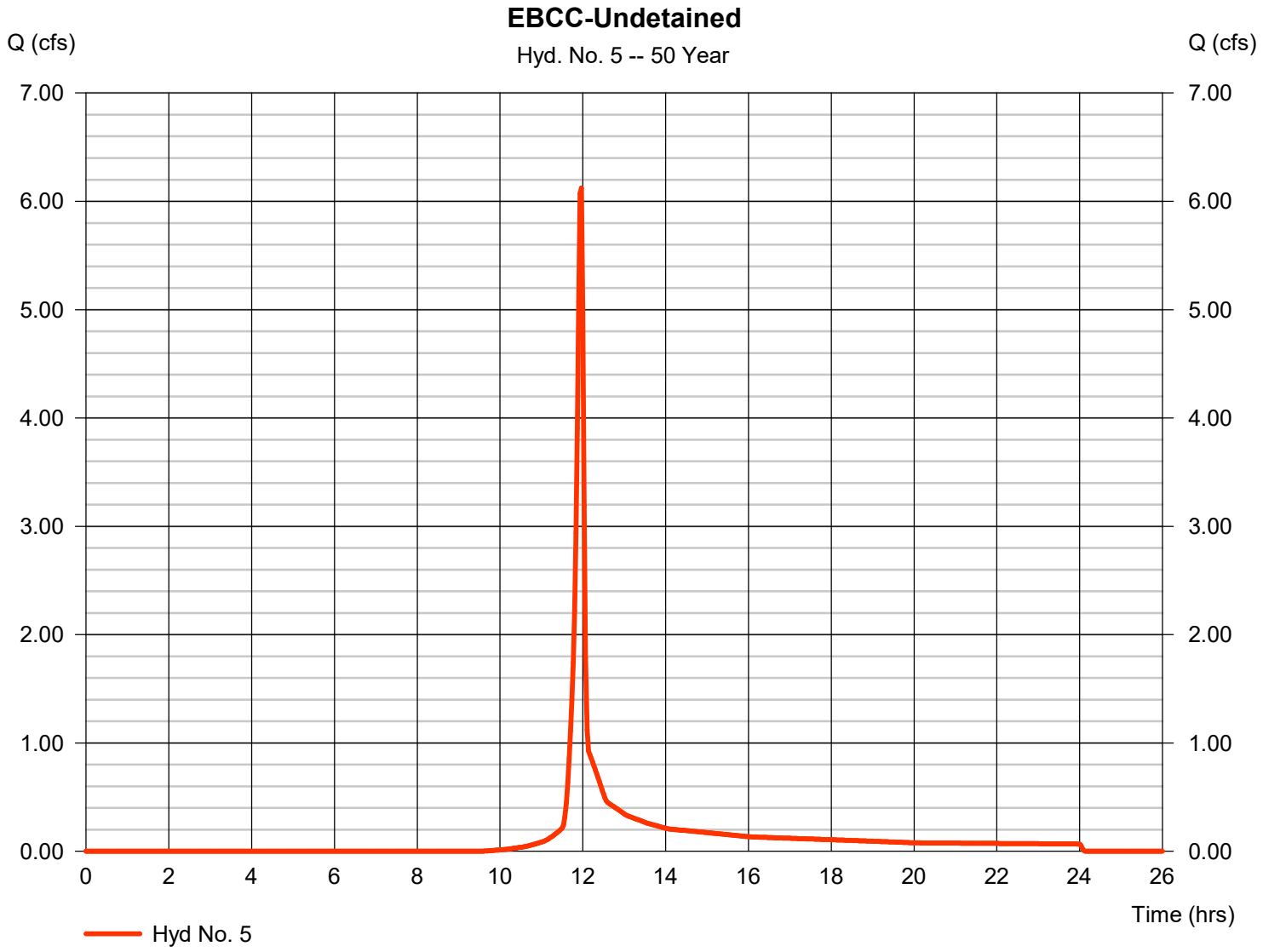
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.123 cfs
Storm frequency	=	50 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	12,283 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



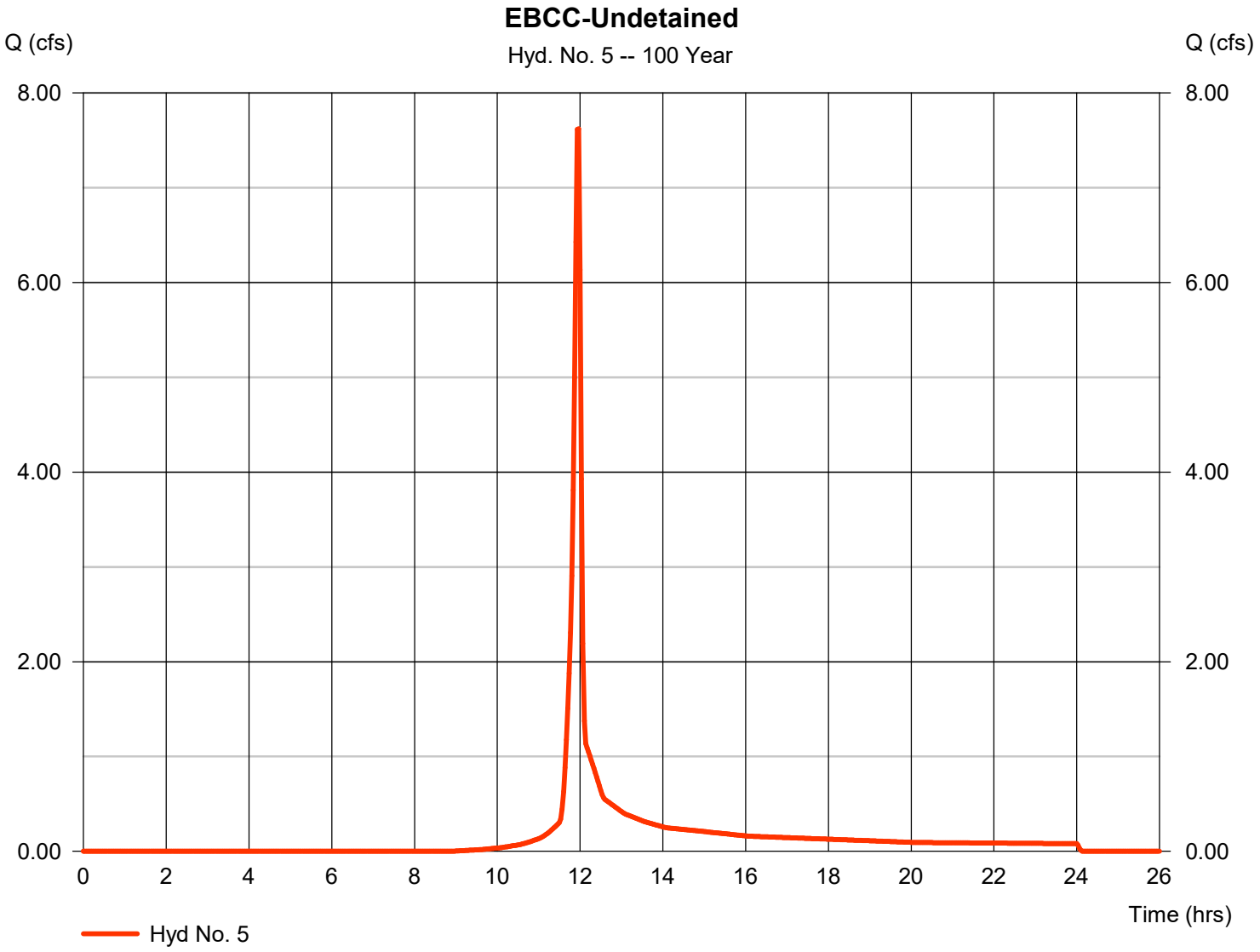
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

EBCC-Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.622 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	2 min	Hyd. volume	=	15,375 cuft
Drainage area	=	1.270 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



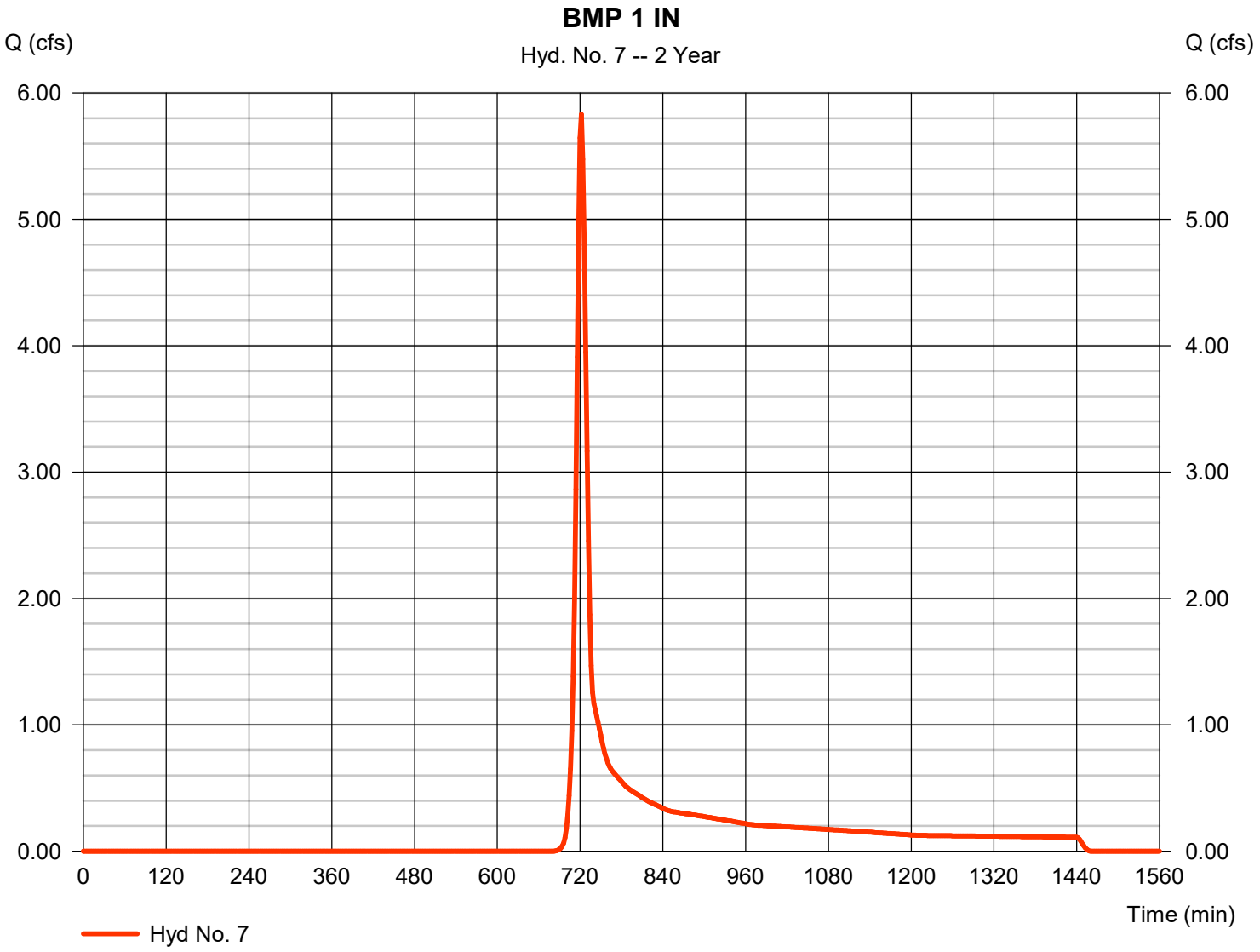
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 7

BMP 1 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.831 cfs
Storm frequency	=	2 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	16,125 cuft
Drainage area	=	4.990 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	13.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

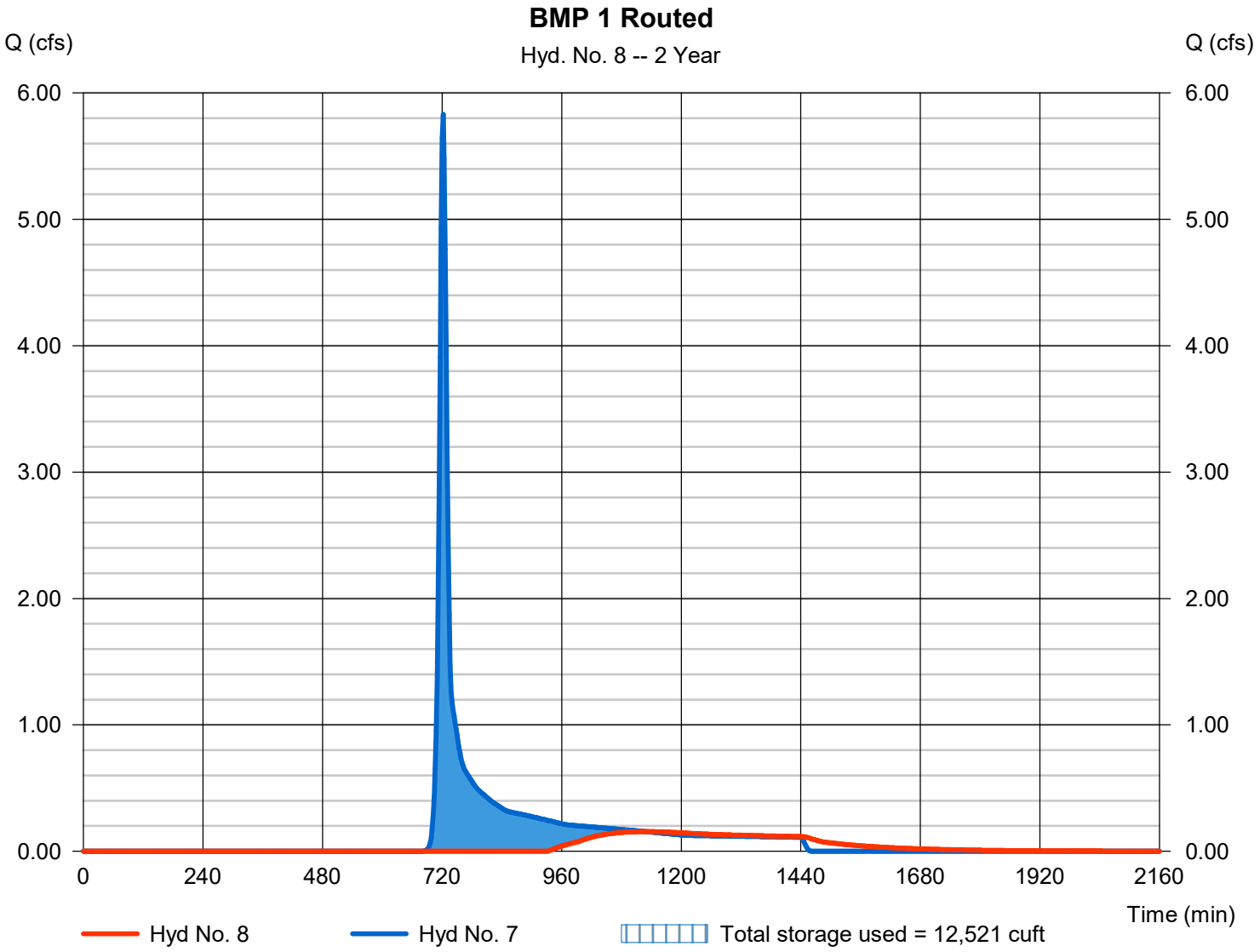
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.155 cfs
Storm frequency	=	2 yrs	Time to peak	=	1128 min
Time interval	=	2 min	Hyd. volume	=	4,613 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	289.58 ft
Reservoir name	=	BMP 1	Max. Storage	=	12,521 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Pond No. 7 - BMP 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 288.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	288.50	10,675	0	0
0.50	289.00	11,498	5,541	5,541
1.00	289.50	12,356	5,962	11,503
1.50	290.00	13,211	6,390	17,893
2.50	291.00	15,025	14,107	32,000
3.50	292.00	16,928	15,965	47,965
4.50	293.00	19,112	18,007	65,972

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	Inactive	0.00	0.00
Span (in)	= 18.00	0.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 284.25	0.00	0.00	0.00
Length (ft)	= 28.47	0.10	0.00	0.00
Slope (%)	= 0.53	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

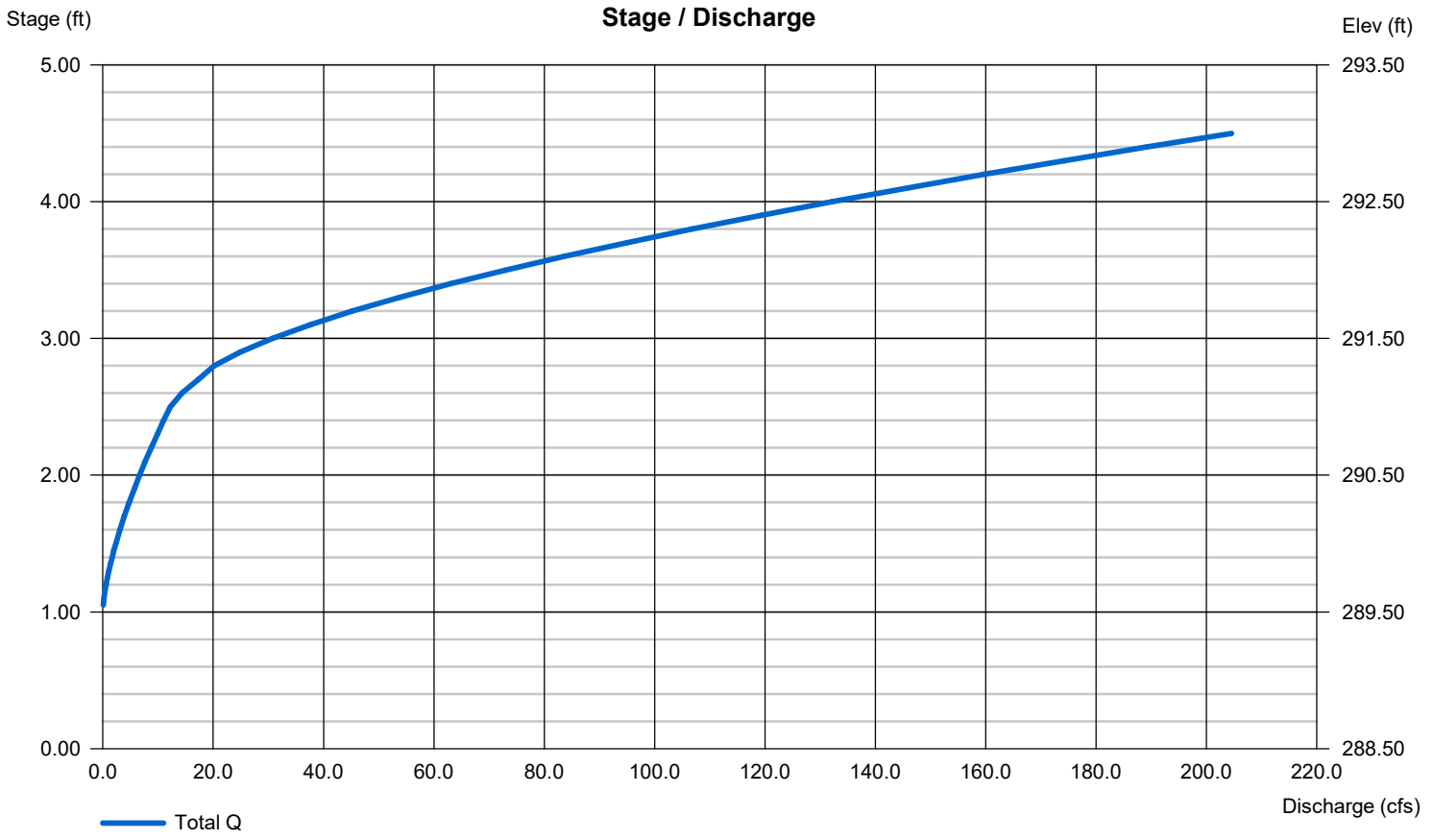
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 8.50	2.00	30.00	0.00
Crest El. (ft)	= 291.00	289.50	291.25	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= 1	Rect	Broad	---
Multi-Stage	= Yes	Yes	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



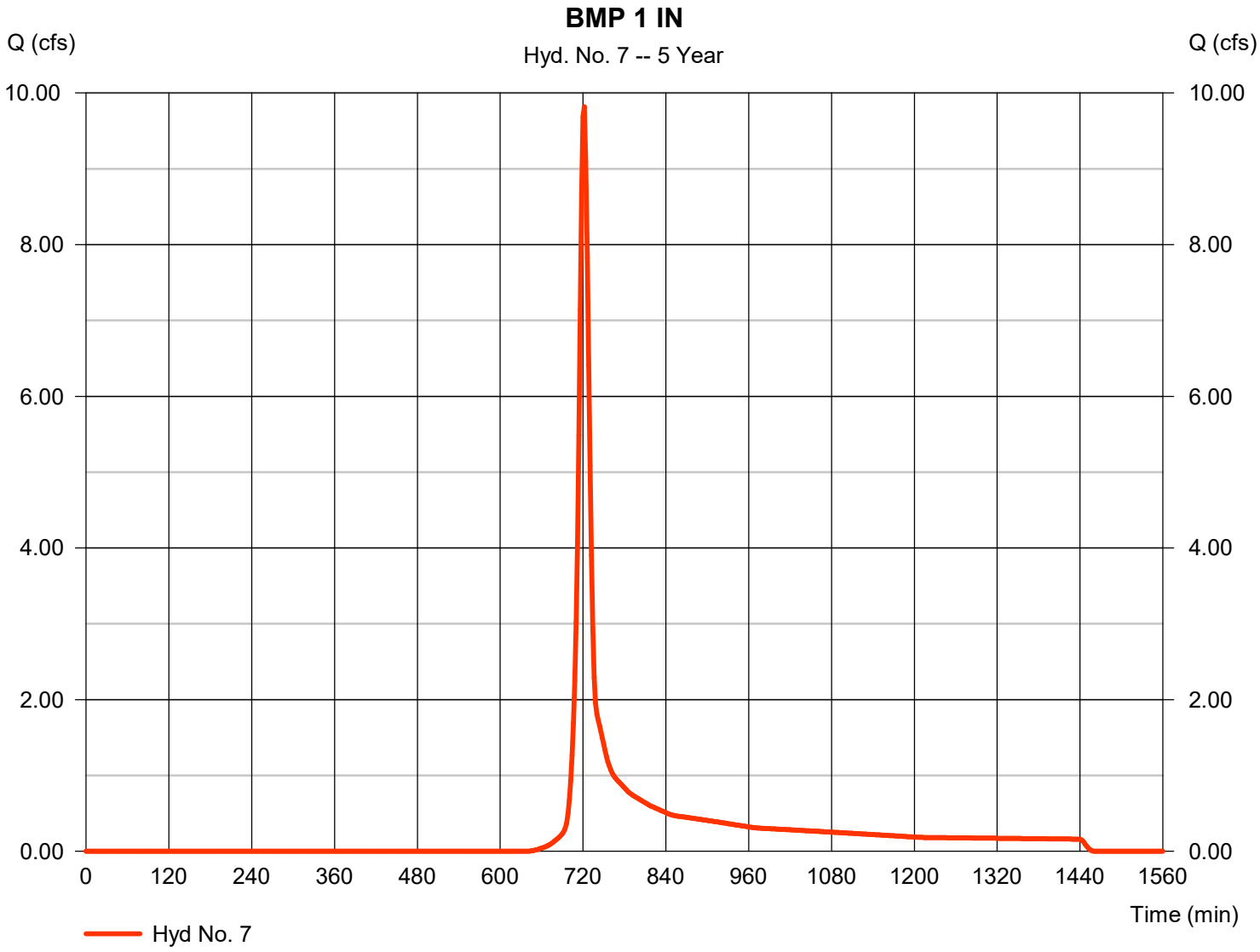
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 7

BMP 1 IN

Hydrograph type	= SCS Runoff	Peak discharge	= 9.819 cfs
Storm frequency	= 5 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 26,092 cuft
Drainage area	= 4.990 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.00 min
Total precip.	= 4.10 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

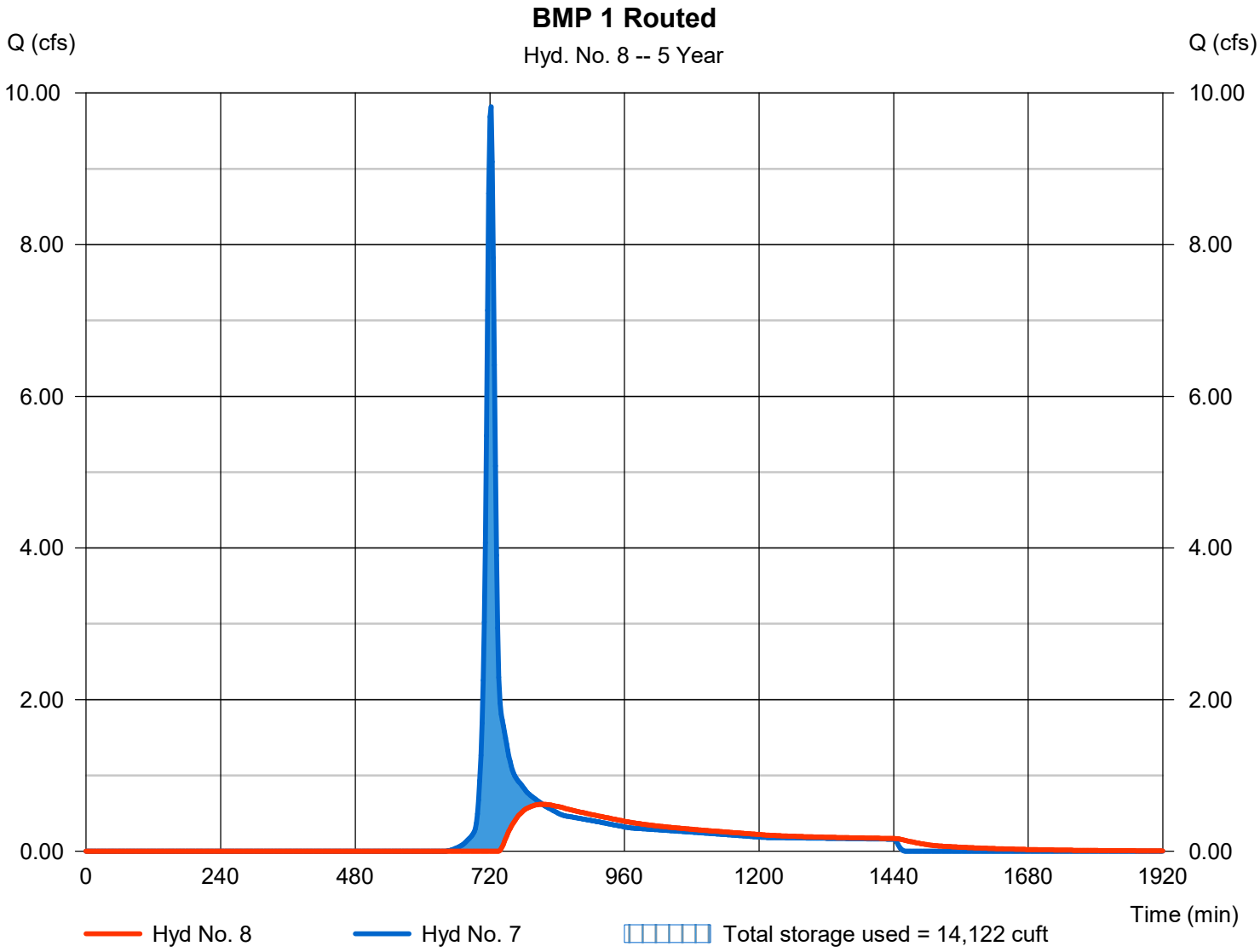
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.619 cfs
Storm frequency	=	5 yrs	Time to peak	=	814 min
Time interval	=	2 min	Hyd. volume	=	14,581 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	289.70 ft
Reservoir name	=	BMP 1	Max. Storage	=	14,122 cuft

Storage Indication method used.



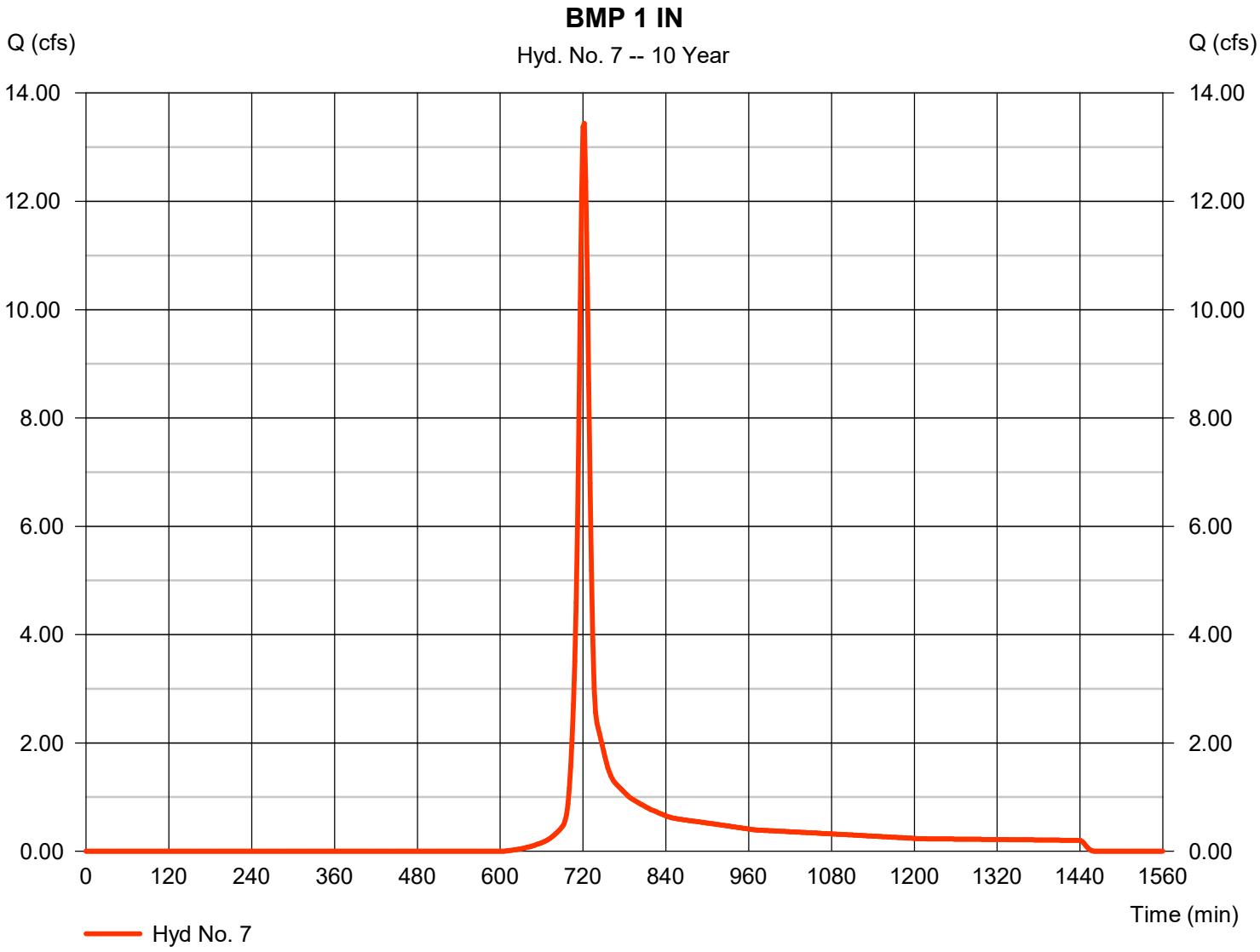
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 7

BMP 1 IN

Hydrograph type	= SCS Runoff	Peak discharge	= 13.44 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 35,291 cuft
Drainage area	= 4.990 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

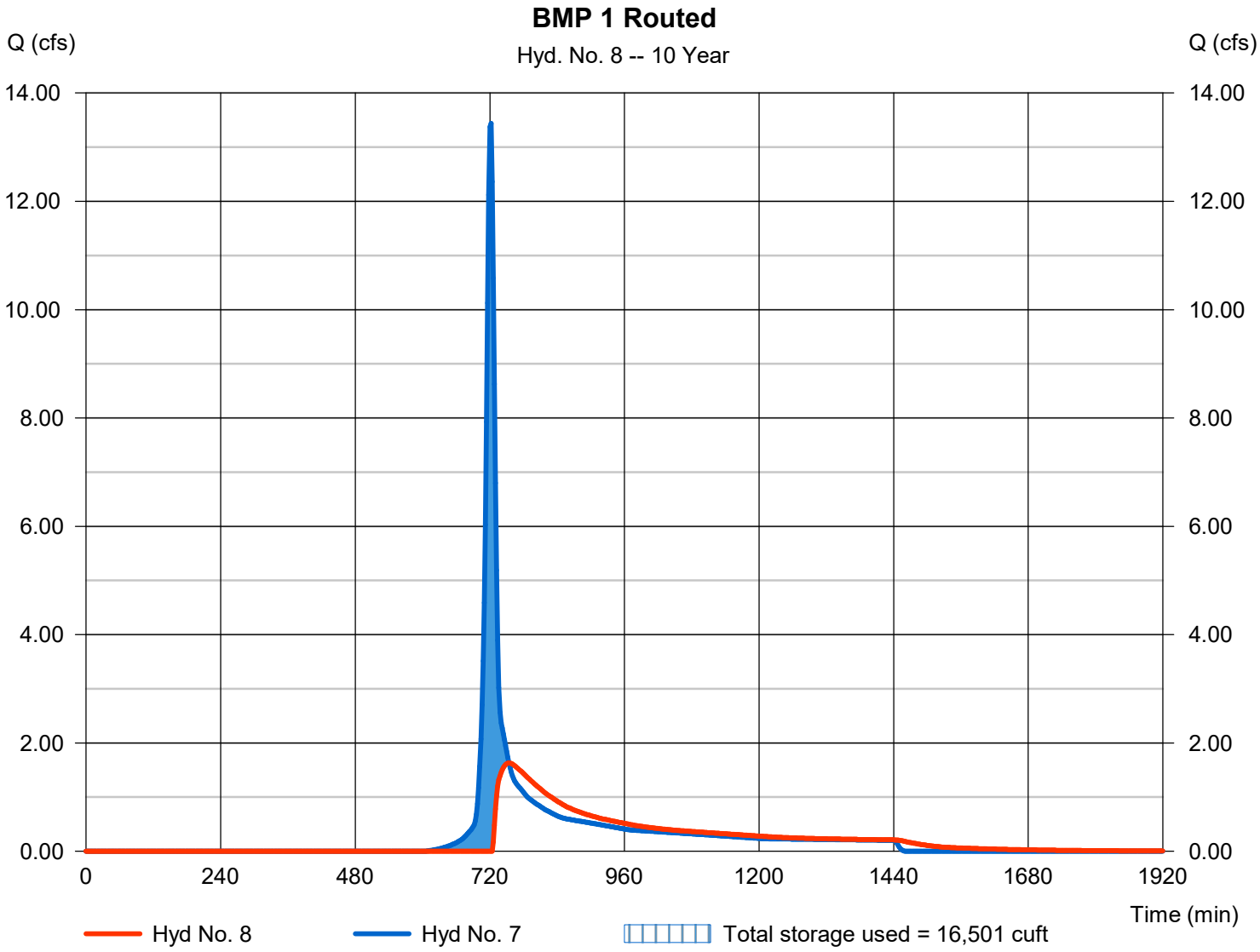
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	1.630 cfs
Storm frequency	=	10 yrs	Time to peak	=	754 min
Time interval	=	2 min	Hyd. volume	=	23,780 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	289.89 ft
Reservoir name	=	BMP 1	Max. Storage	=	16,501 cuft

Storage Indication method used.

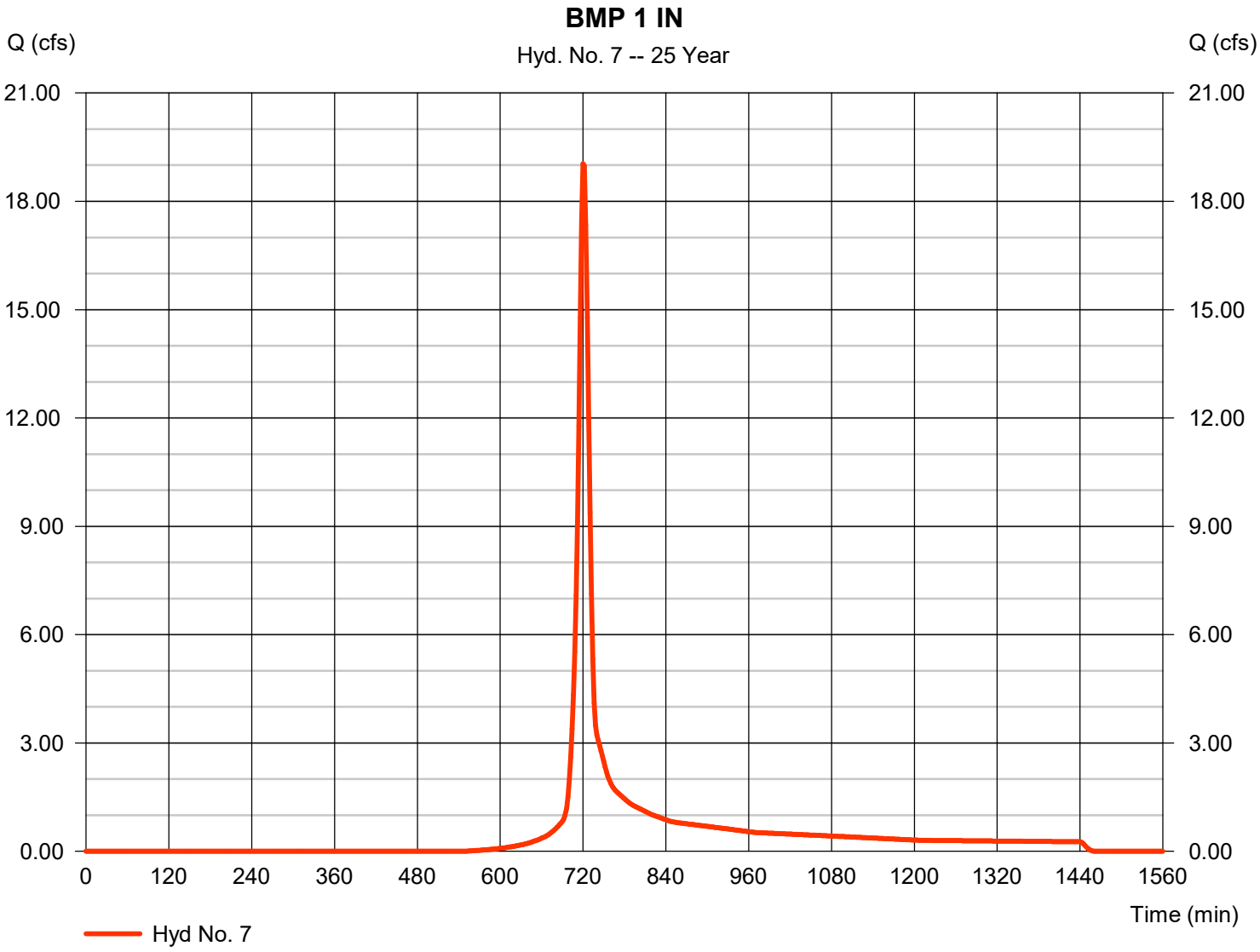


Hydrograph Report

Hyd. No. 7

BMP 1 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	19.04 cfs
Storm frequency	=	25 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	49,600 cuft
Drainage area	=	4.990 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	13.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

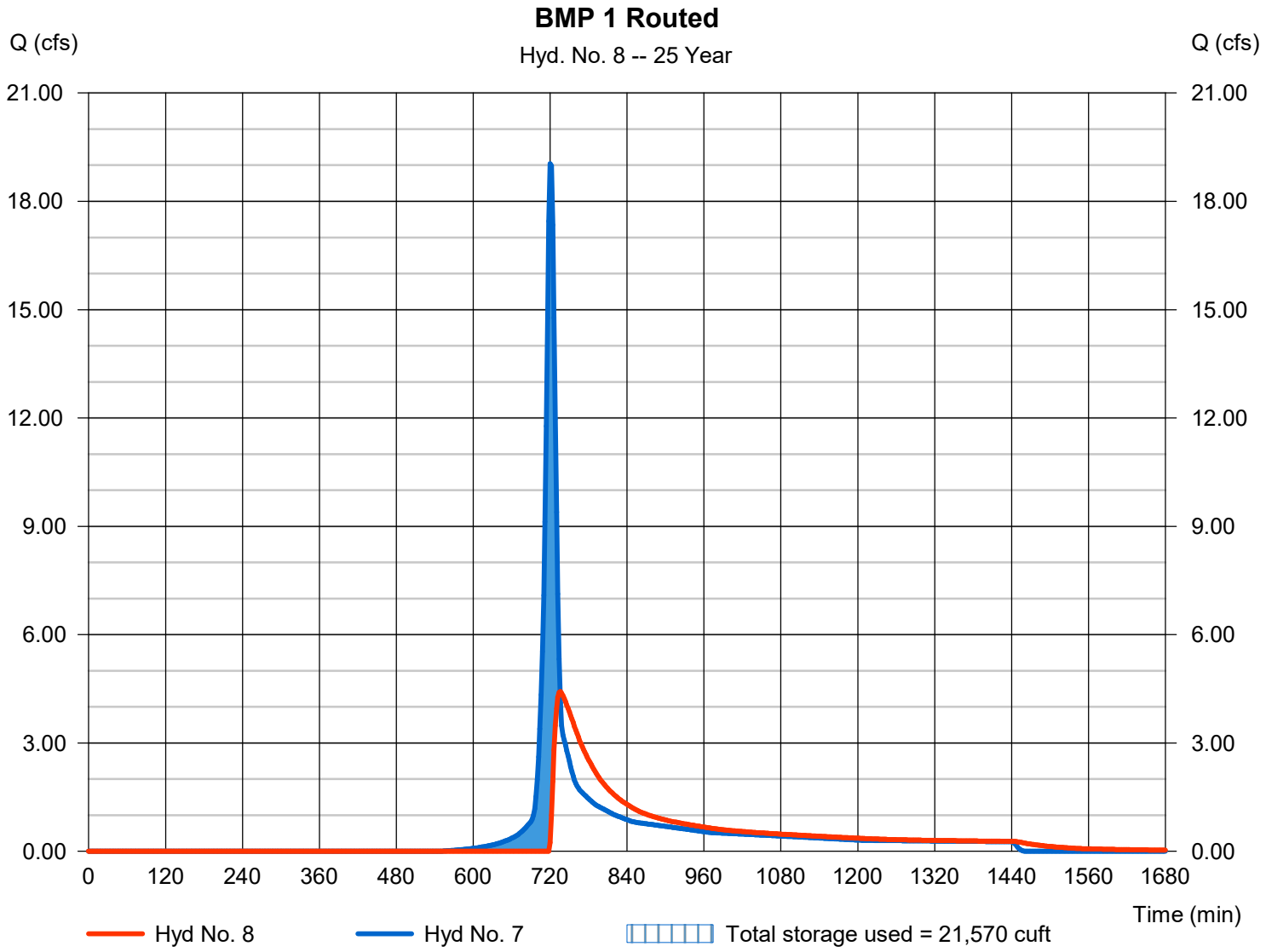
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	4.425 cfs
Storm frequency	=	25 yrs	Time to peak	=	736 min
Time interval	=	2 min	Hyd. volume	=	38,088 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	290.26 ft
Reservoir name	=	BMP 1	Max. Storage	=	21,570 cuft

Storage Indication method used.



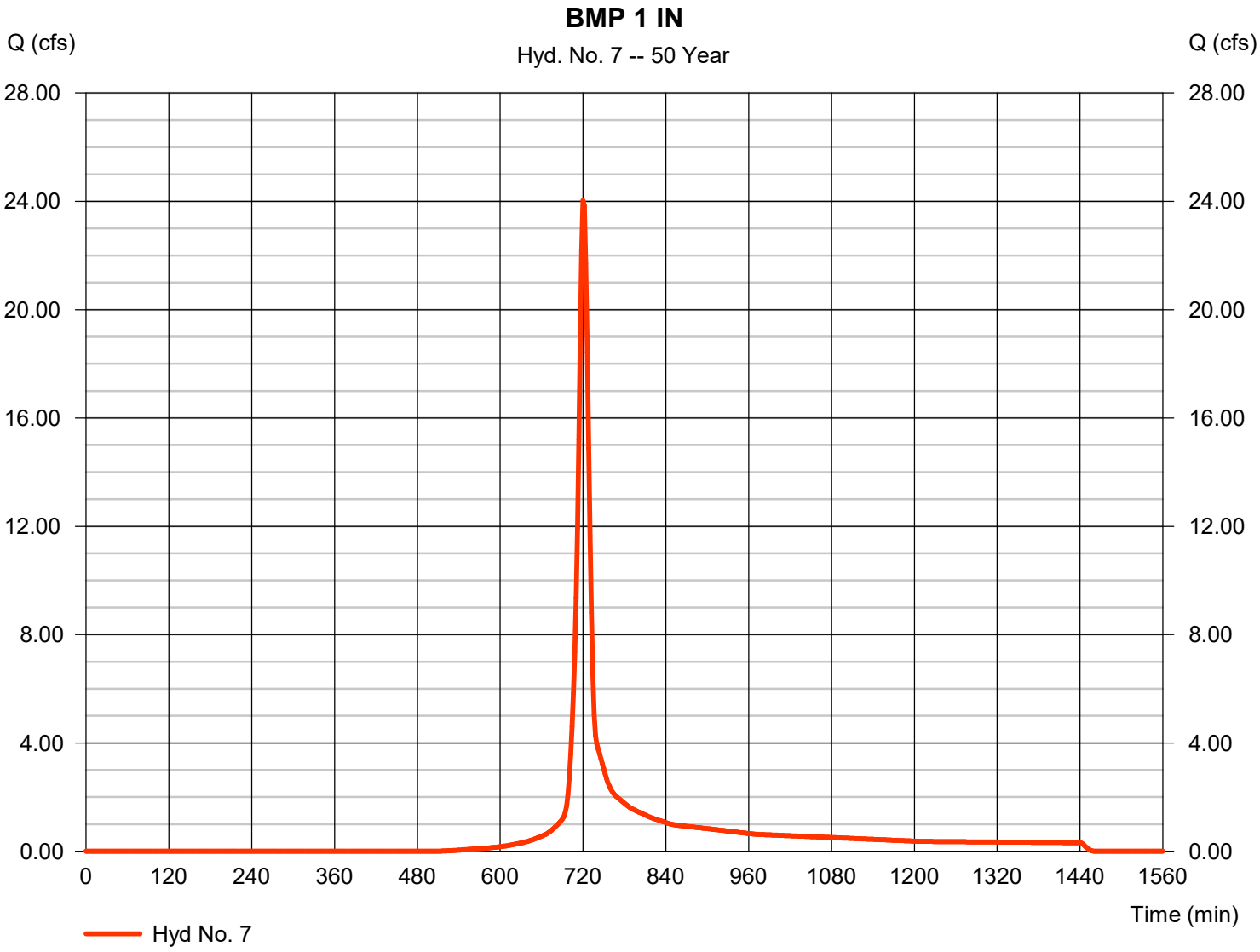
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 7

BMP 1 IN

Hydrograph type	= SCS Runoff	Peak discharge	= 24.03 cfs
Storm frequency	= 50 yrs	Time to peak	= 720 min
Time interval	= 2 min	Hyd. volume	= 62,348 cuft
Drainage area	= 4.990 ac	Curve number	= 70
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 13.00 min
Total precip.	= 6.66 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

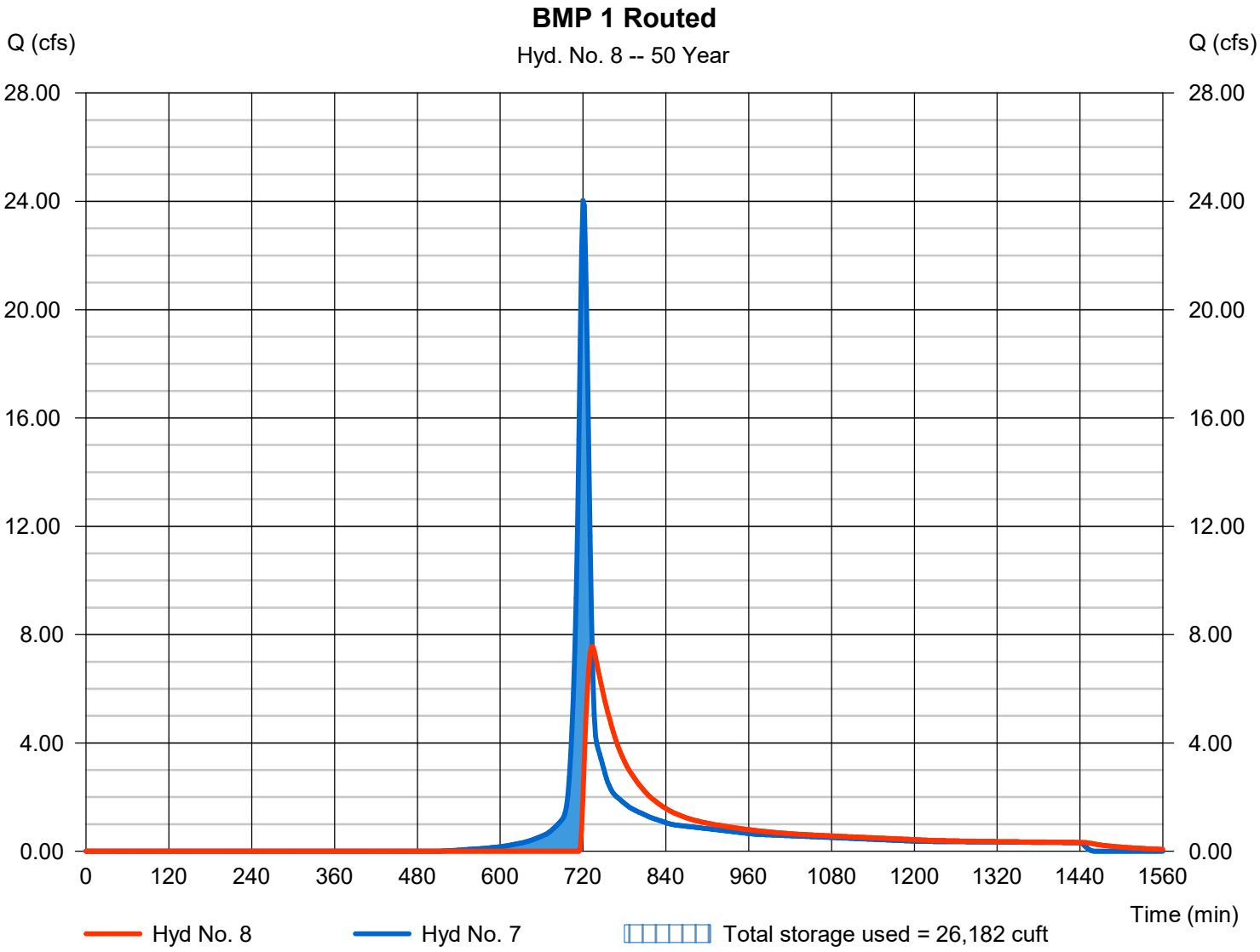
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	7.557 cfs
Storm frequency	=	50 yrs	Time to peak	=	734 min
Time interval	=	2 min	Hyd. volume	=	50,837 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	290.59 ft
Reservoir name	=	BMP 1	Max. Storage	=	26,182 cuft

Storage Indication method used.



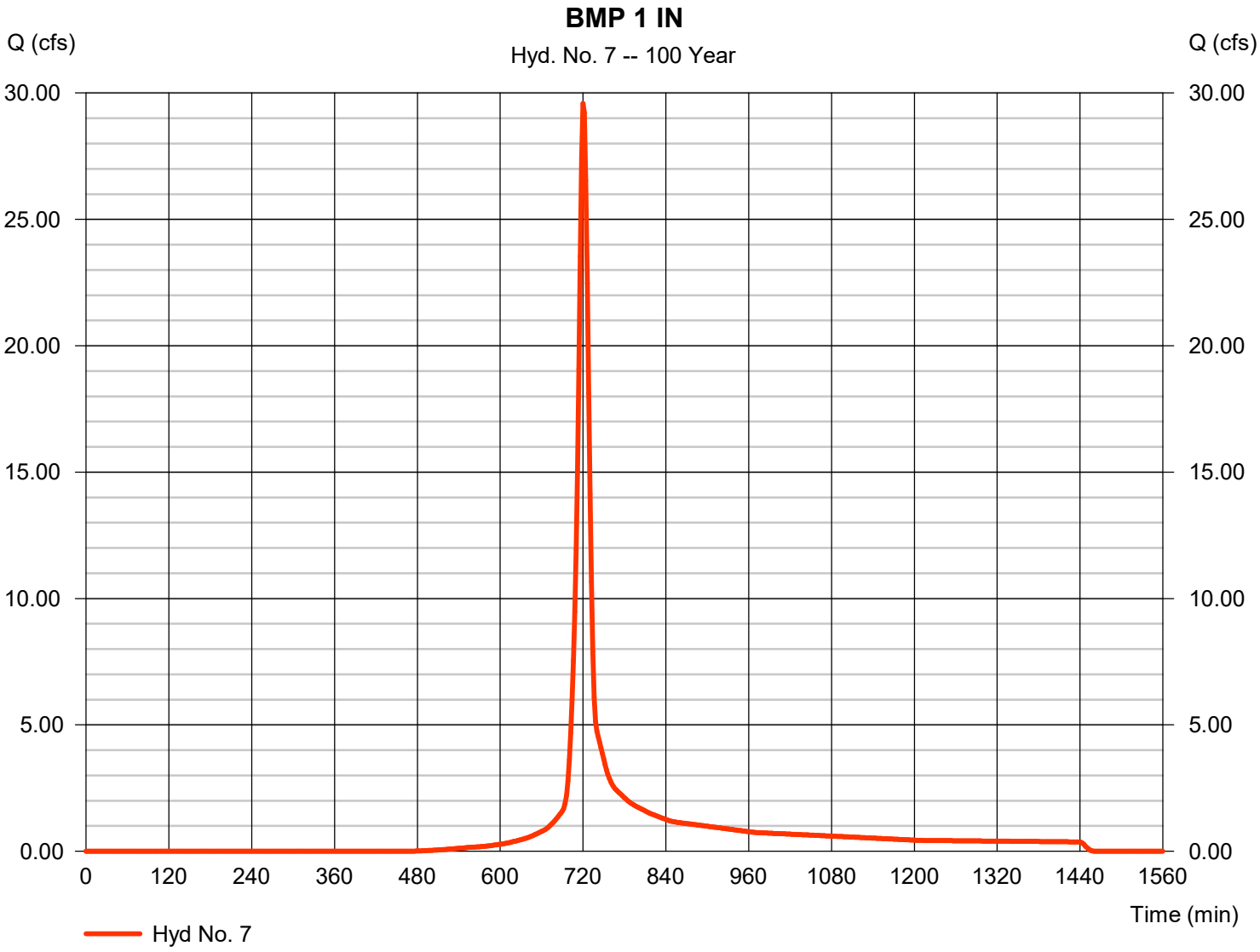
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 7

BMP 1 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	29.58 cfs
Storm frequency	=	100 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	76,692 cuft
Drainage area	=	4.990 ac	Curve number	=	70
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	13.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



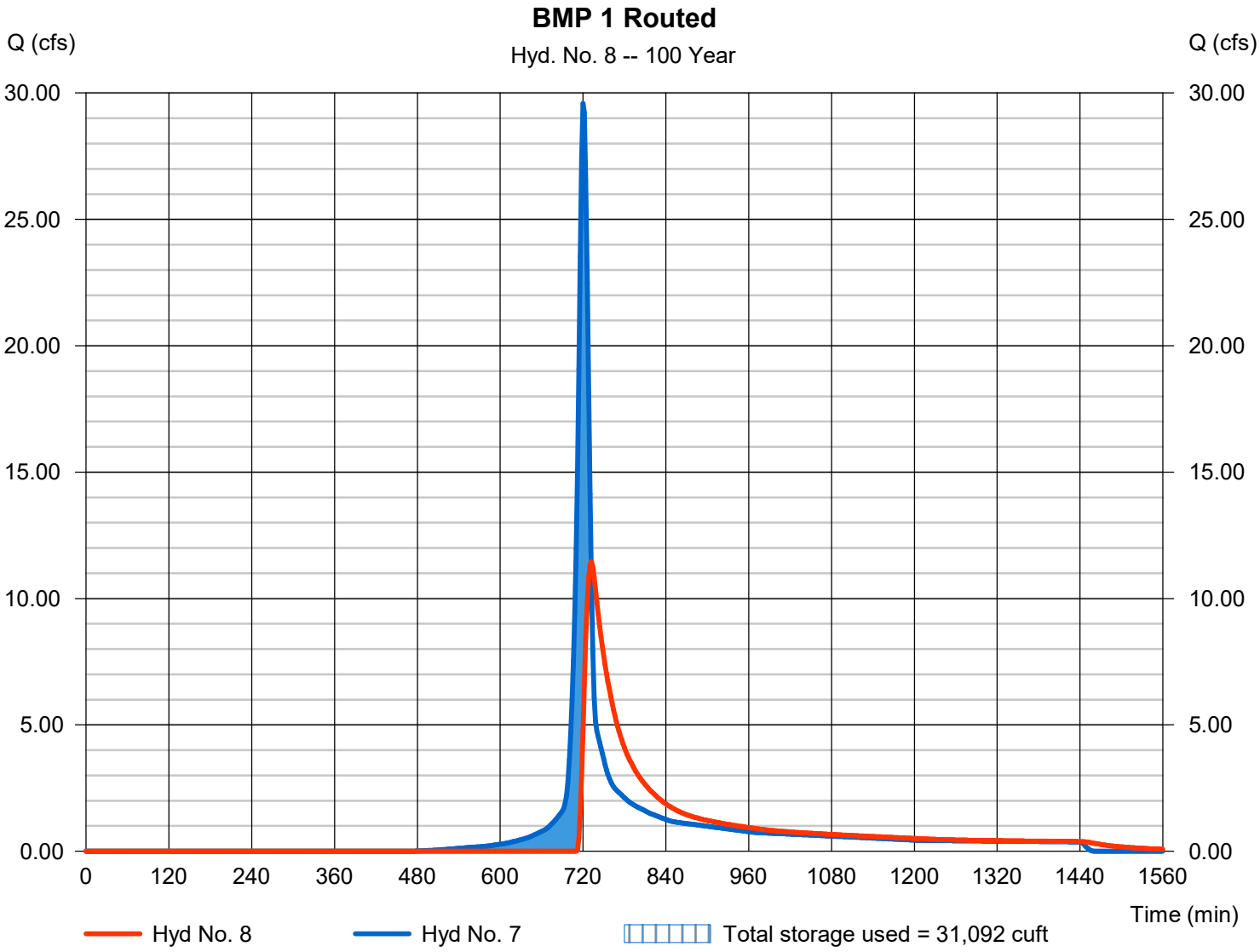
Hydrograph Report

Hyd. No. 8

BMP 1 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	11.46 cfs
Storm frequency	=	100 yrs	Time to peak	=	732 min
Time interval	=	2 min	Hyd. volume	=	65,180 cuft
Inflow hyd. No.	=	7 - BMP 1 IN	Max. Elevation	=	290.94 ft
Reservoir name	=	BMP 1	Max. Storage	=	31,092 cuft

Storage Indication method used.



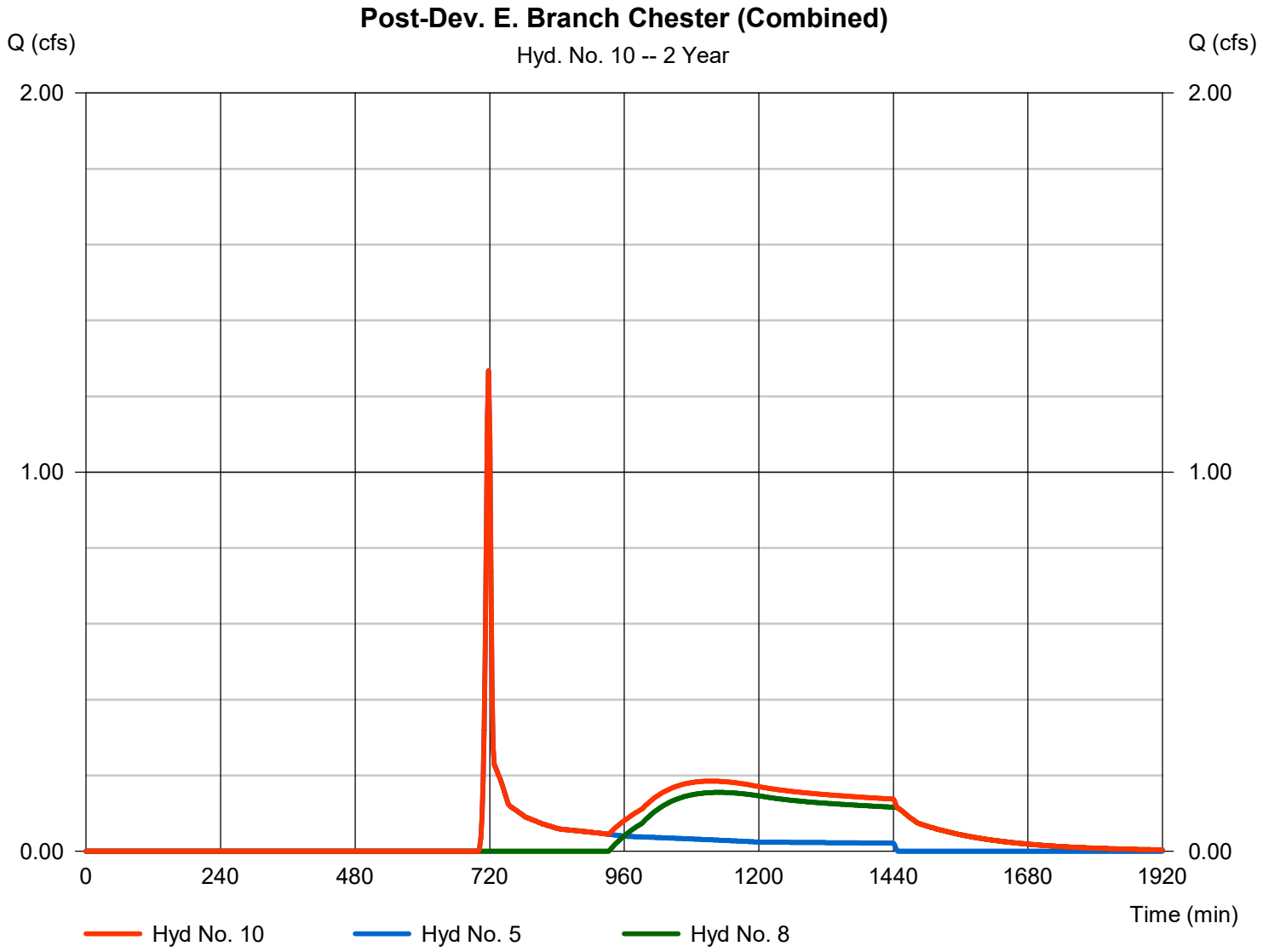
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 1.267 cfs
Storm frequency	= 2 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 7,335 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac



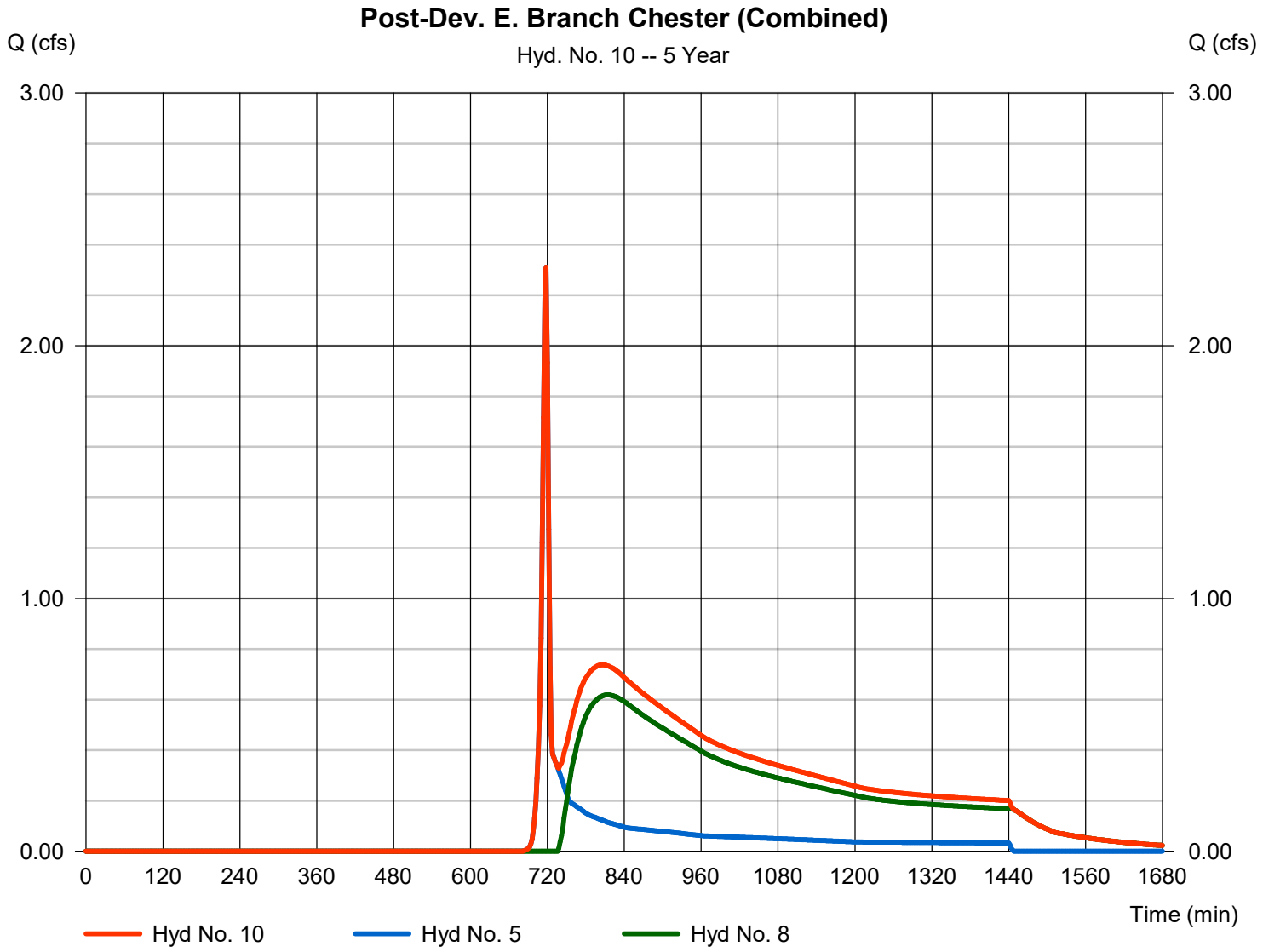
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 2.311 cfs
Storm frequency	= 5 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 19,279 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac



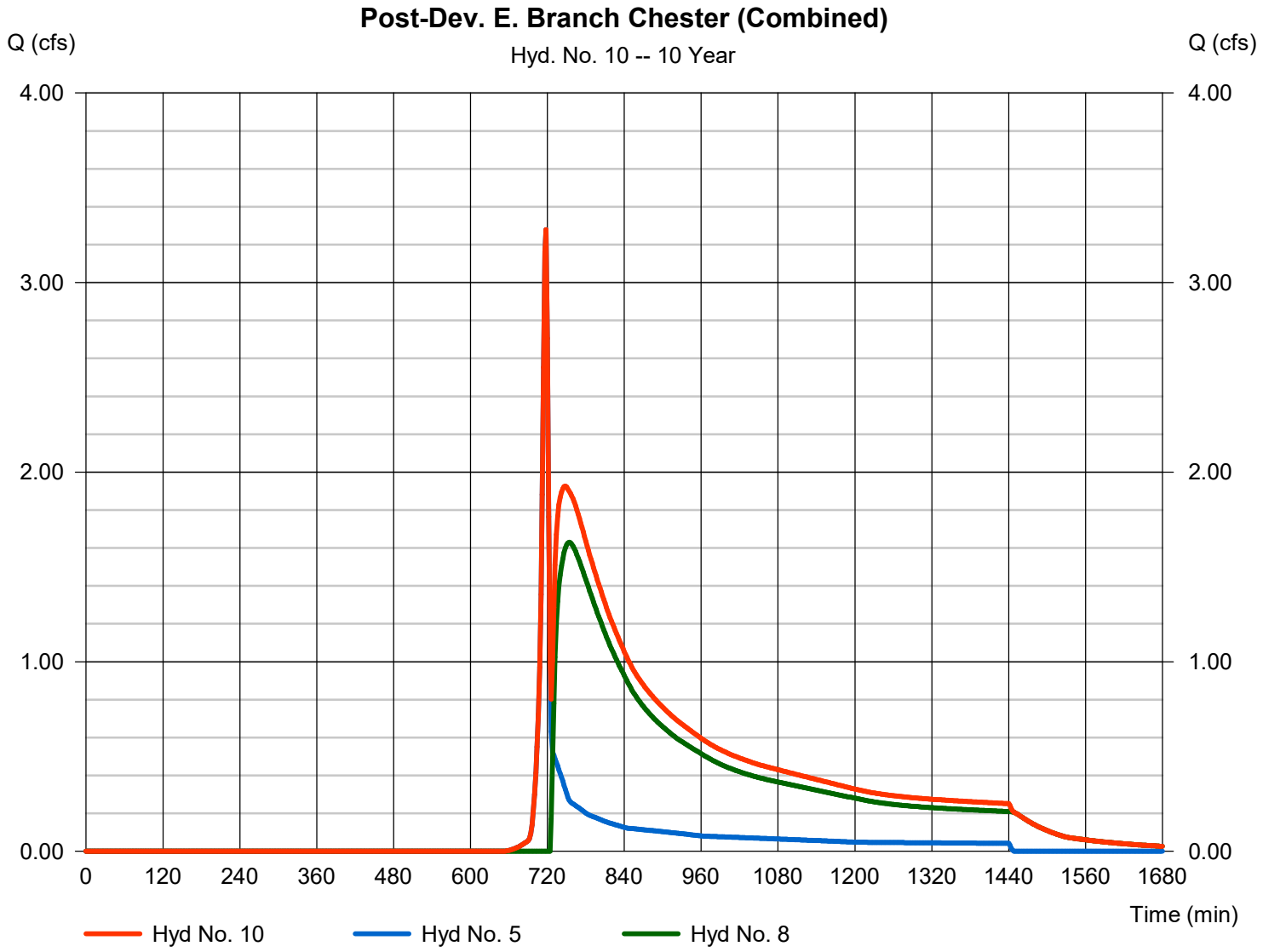
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 3.279 cfs
Storm frequency	= 10 yrs	Time to peak	= 718 min
Time interval	= 2 min	Hyd. volume	= 30,358 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac



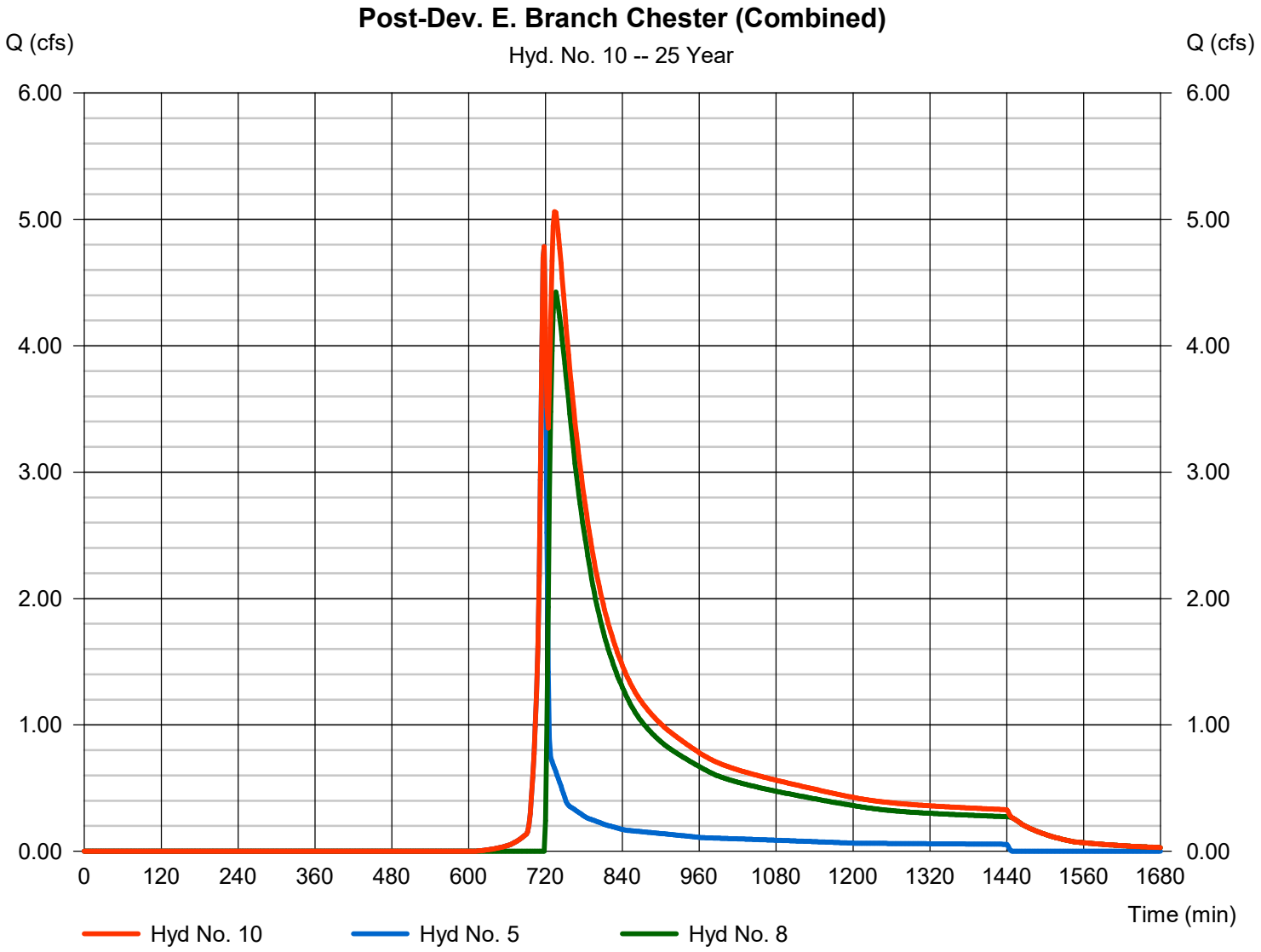
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 5.061 cfs
Storm frequency	= 25 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 47,657 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac

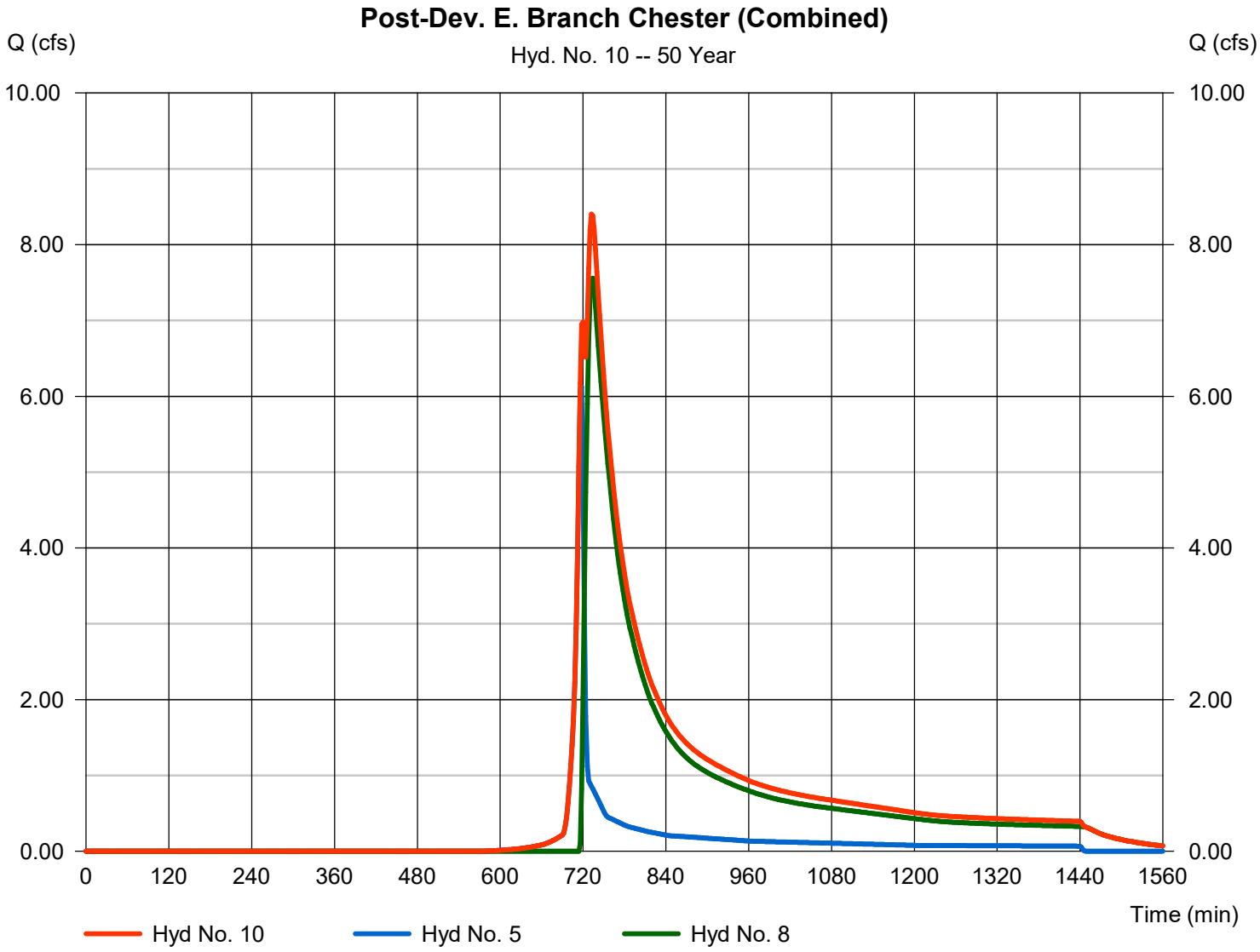


Hydrograph Report

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 8.403 cfs
Storm frequency	= 50 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 63,120 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac

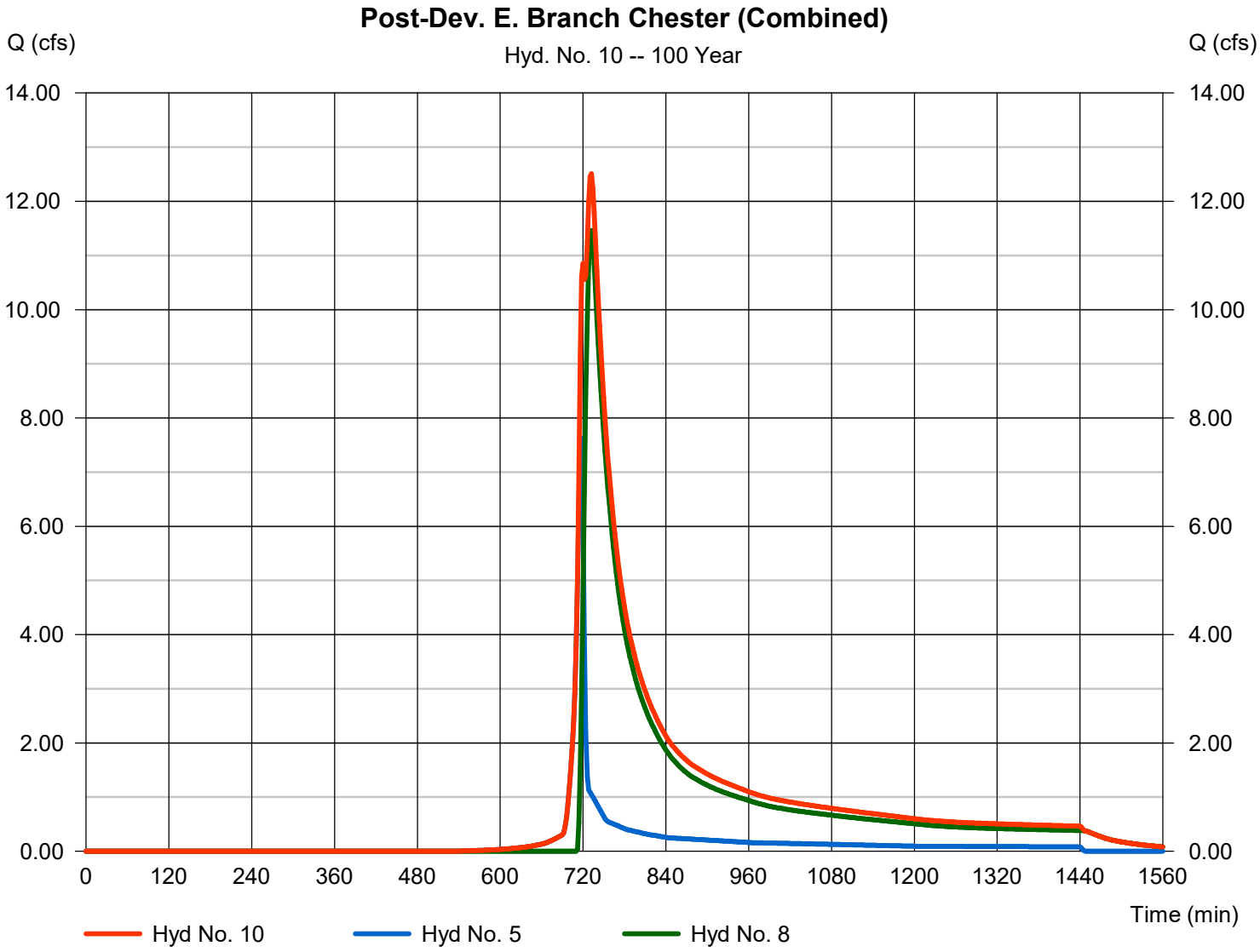


Hydrograph Report

Hyd. No. 10

Post-Dev. E. Branch Chester (Combined)

Hydrograph type	= Combine	Peak discharge	= 12.51 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 80,555 cuft
Inflow hyds.	= 5, 8	Contrib. drain. area	= 1.270 ac



UNT. TO
EAST BRANCH CHESTER CREEK

ELA SPORT
ATHLETIC FACILITIES
DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

NRCS (SCS) TR-55- WATERSHED WEIGHTED CURVE NUMBER POST-DEVELOPMENT SUMMARY

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

	LAND USE	Parking, Other Impervious (Disturbed Area)	Parking, Other Impervious (Undisturbed Area)	Open Space (Disturbed Area)	Open Space (Undsturbed Area)	Open Space (Disturbed Area)	Open Space (Undsturbed Area)			
	HSG	B	B	B	B	D	D			
	"CN" Value	98	98	61	61	80	80	Total	Composite	Tc
WATERSHED		Area (ac)						Area (ac.)	'CN' Value	Min.
Infiltration Basin - BMP 4		0.30	0.00	5.12	2.79	0.54	0.92	9.67	65	22
Infiltration Bed - BMP 2		2.22	0.00	0.00	0.00	0.00	0.00	2.22	98	5
Infiltration Bed - BMP 3		2.22	0.00	0.00	0.00	0.00	0.00	2.22	98	5
Undetained		0.00	0.00	2.01	0.93	0.60	0.04	3.59	64	12

ELA SPORT
ATHLETIC FACILITIES
DESIGN & CONSULTING

737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

SUMMARY - SUBAREAS TIME OF CONCENTRATION PRE-DEVELOPMENT CONDITIONS

PROJECT:	The Westtown School - Oak Lane Project
LOCATION:	Westtown Township
COUNTY:	Chester

Time of concentration (Tc) or travel time (Tt)
NRCS Velocity(Segmental) Method

	overland					Shallow Concentrated					Channel or Pipe								Total	
Sub area	Length L_1 100 ft. max.	Slope S_1	Manning's n	2 yr rainfall	Tc	Flow Path Cover	Length L_2	Slope S_2	Average Velocity	Tt	Channel or Pipe	Flow Area	Wetted Perimeter	Pipe Diameter	Slope S_3	Manning's n	Length L_3	Tt	Σ Tc	
	ft.	ft./ft.	n	in.	Min.	U/P	ft.	ft./ft.	ft./s	Min.	C/P	sq.ft.	ft.	in.	ft./ft.	n	ft.	Min.	Min.	Hrs.
BMP 1	100	0.011	0.24	3.26	18				0	0.0		0.00	0.00					0		
				3.26	0	U	350	0.011	1.7	3.4		0.00	0.00					0		
				3.26	0	U	62	0.167	6.6	0.2		0.00	0.00					0		
					0				0	0		0.00	0.00					0		
					0				0	0		0.00	0.00					0.0		
					18					3.6								0.0	**22**	0.37
Unt. to EBCC	100	0.040	0.24	3.26	10.7				0	0.0		0.00	0.00					0.0		
Undetained					0	U	313	0.048	3.5	1.5		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
												0.00	0.00					0.0		
					0				0	0		0.00	0.00					0.0		
					10.7					1.5								0	**12**	0.20

FILE NAME:WESTTOWN-STORM.xlsx - Post_Tc_(B)

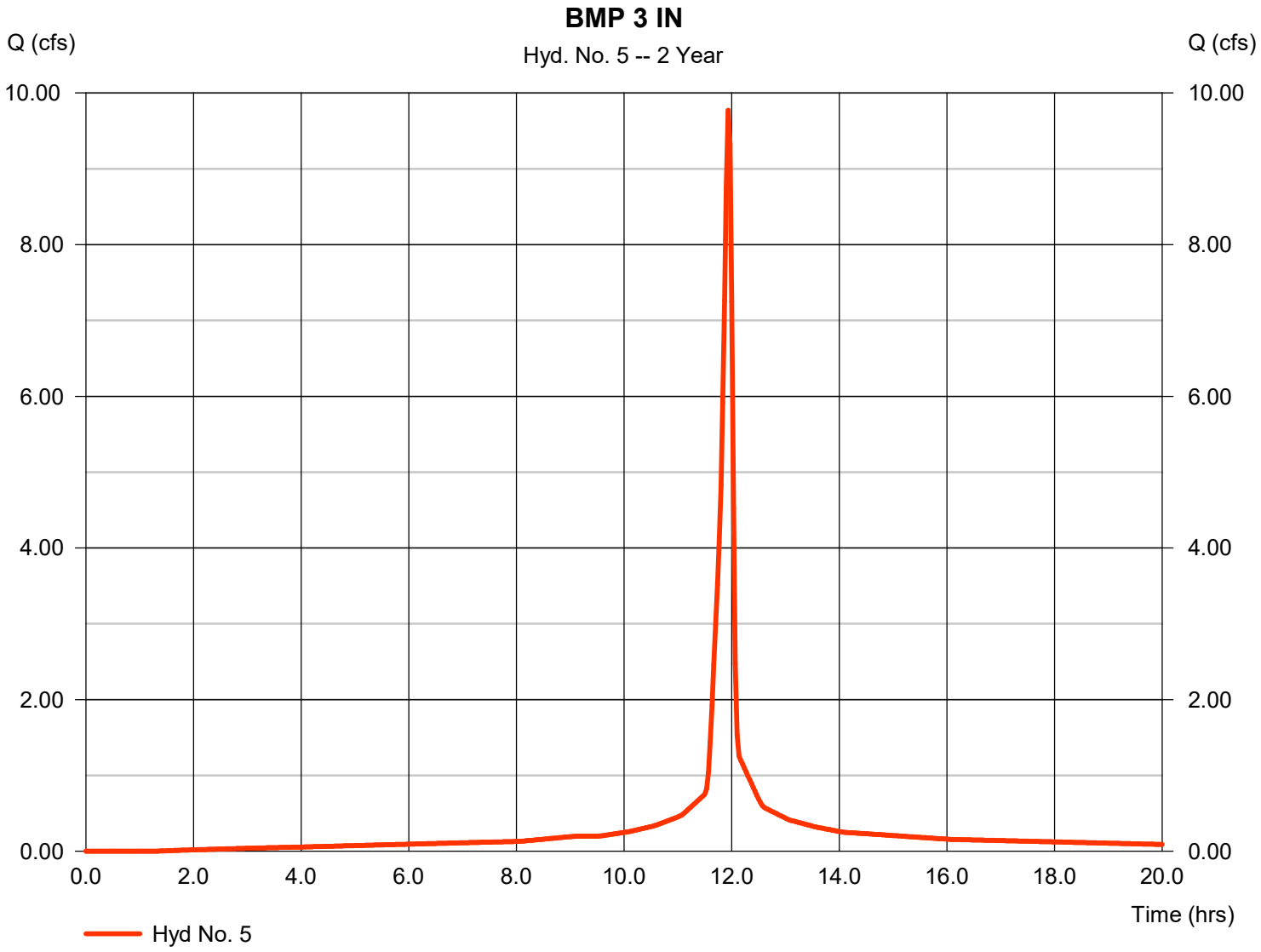
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

BMP 3 IN

Hydrograph type	= SCS Runoff	Peak discharge	= 9.771 cfs
Storm frequency	= 2 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 22,871 cuft
Drainage area	= 2.220 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.26 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

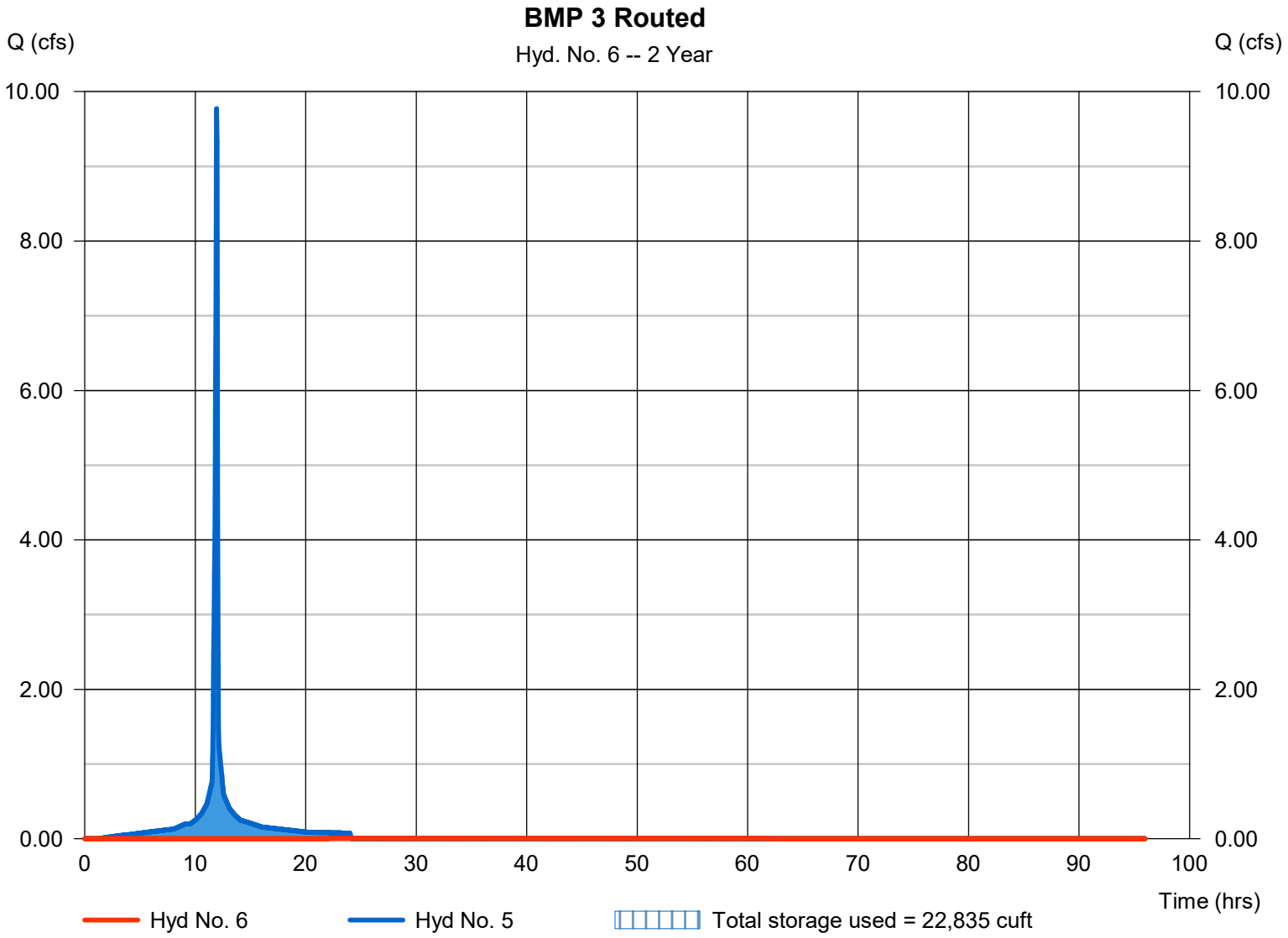
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.006 cfs
Storm frequency	= 2 yrs	Time to peak	= 24.10 hrs
Time interval	= 2 min	Hyd. volume	= 772 cuft
Inflow hyd. No.	= 5 - BMP 3 IN	Max. Elevation	= 321.04 ft
Reservoir name	= BMP 3	Max. Storage	= 22,835 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Pond No. 7 - BMP 3

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	319.00	n/a	0	0
1.00	320.00	n/a	10,878	10,878
2.00	321.00	n/a	11,038	21,916
2.65	321.65	n/a	14,567	36,483
2.75	321.75	n/a	3,600	40,083
3.50	322.50	n/a	28,665	68,748

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	3.00	0.00	0.00
Span (in)	= 12.00	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 319.00	321.00	0.00	0.00
Length (ft)	= 245.00	0.10	0.00	0.00
Slope (%)	= 0.75	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

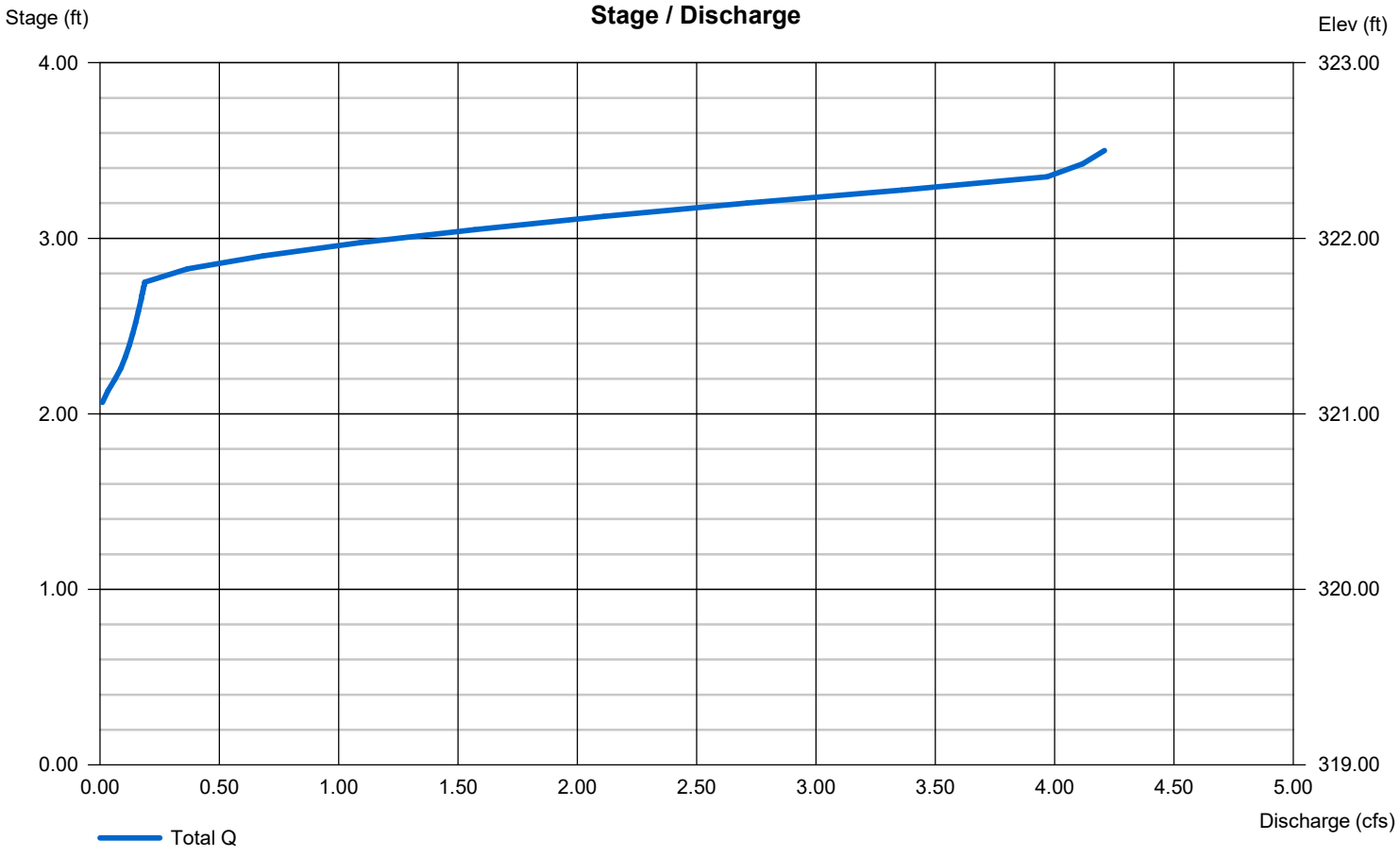
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	0.00	0.00	0.00
Crest El. (ft)	= 321.75	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

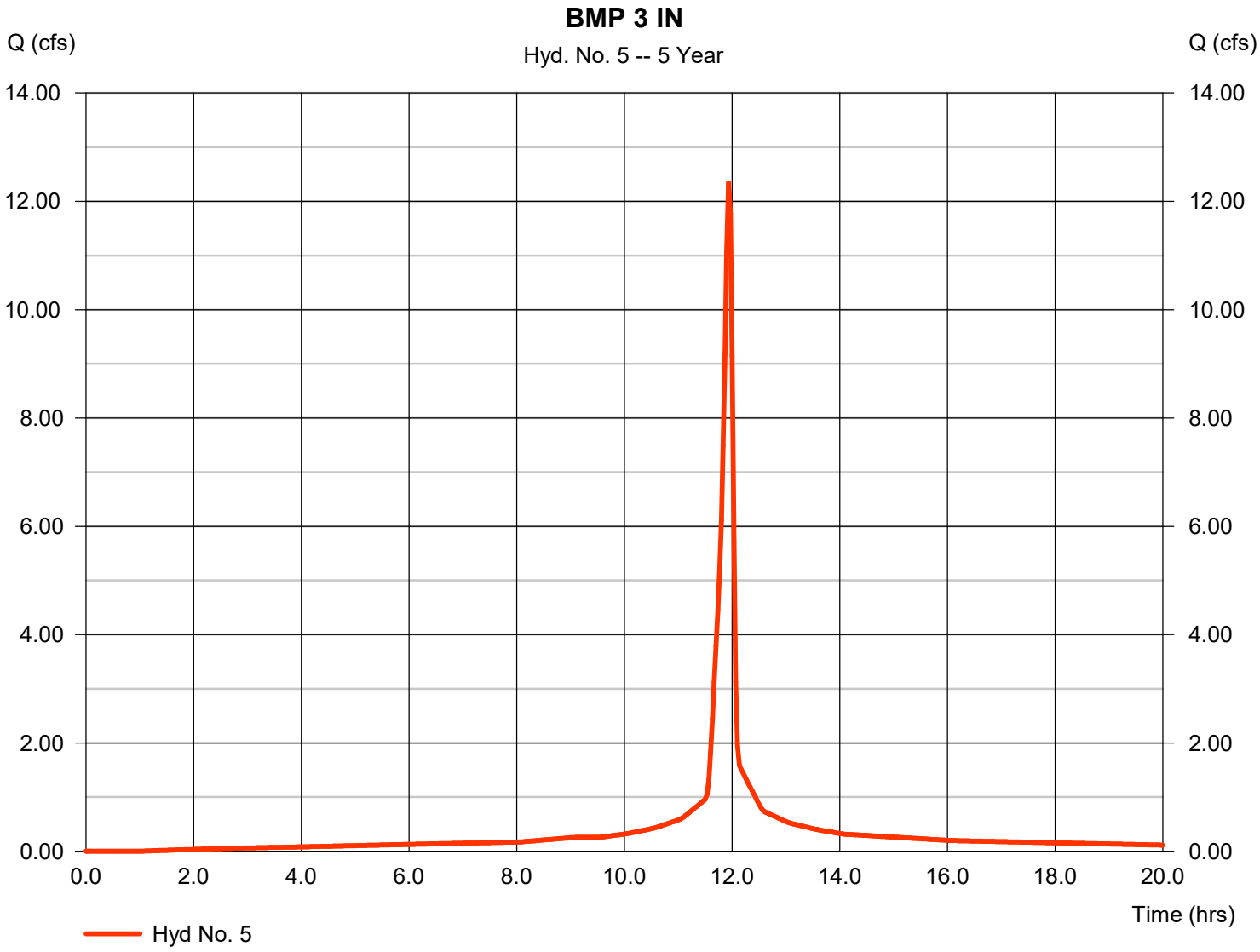


Hydrograph Report

Hyd. No. 5

BMP 3 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.34 cfs
Storm frequency	=	5 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	29,199 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

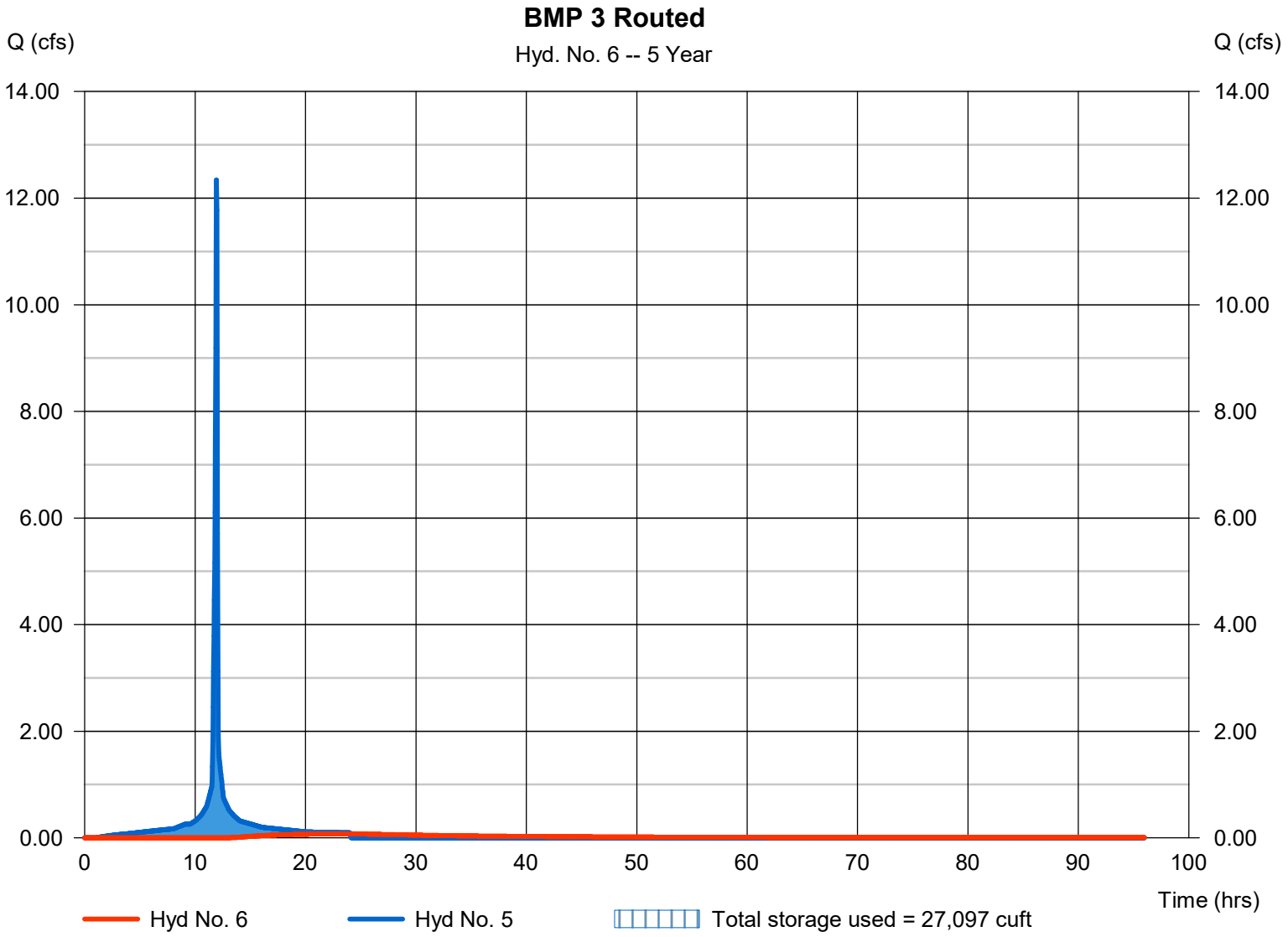
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.076 cfs
Storm frequency	= 5 yrs	Time to peak	= 24.03 hrs
Time interval	= 2 min	Hyd. volume	= 6,655 cuft
Inflow hyd. No.	= 5 - BMP 3 IN	Max. Elevation	= 321.23 ft
Reservoir name	= BMP 3	Max. Storage	= 27,097 cuft

Storage Indication method used.



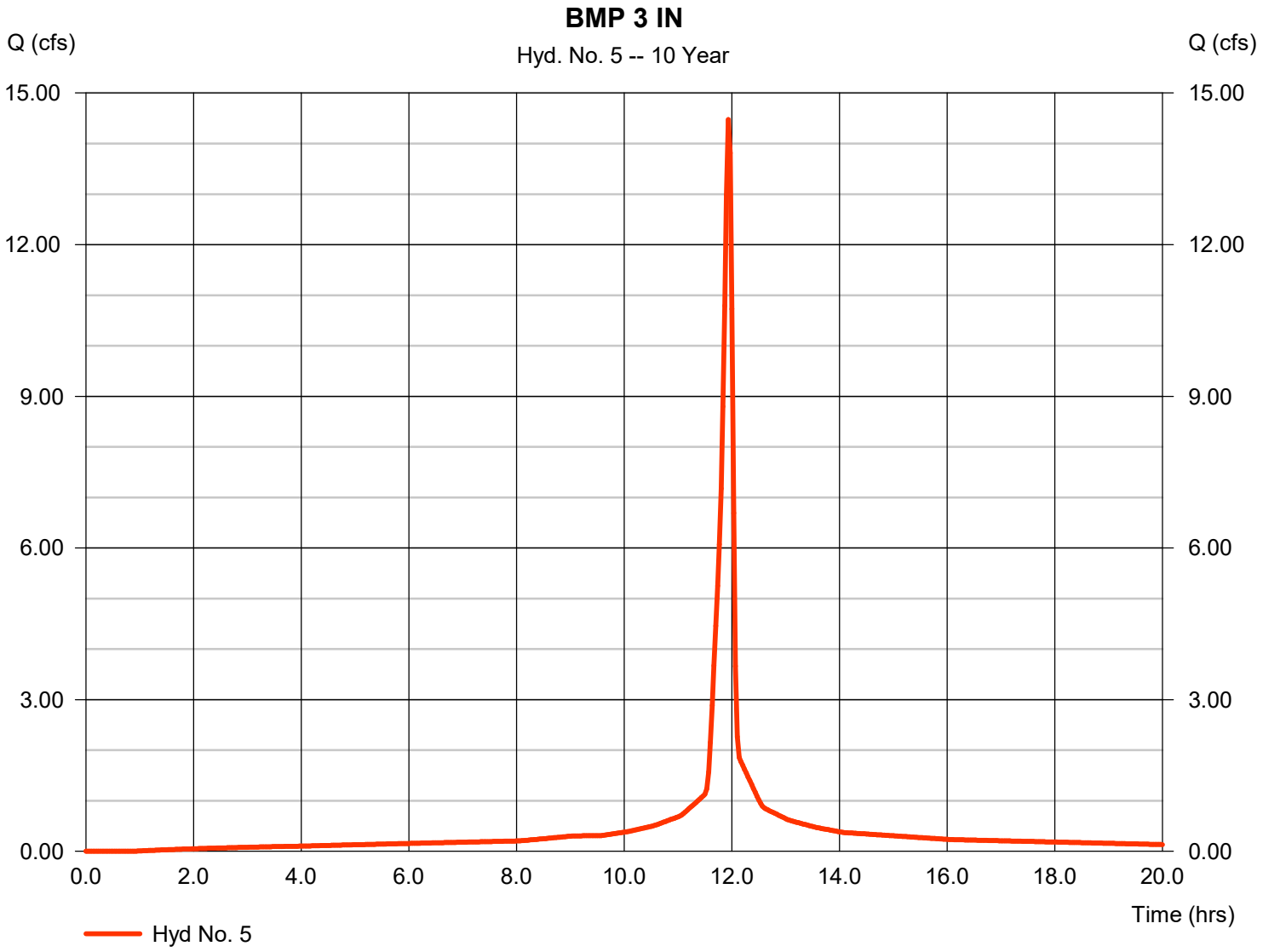
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

BMP 3 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.48 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	34,477 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

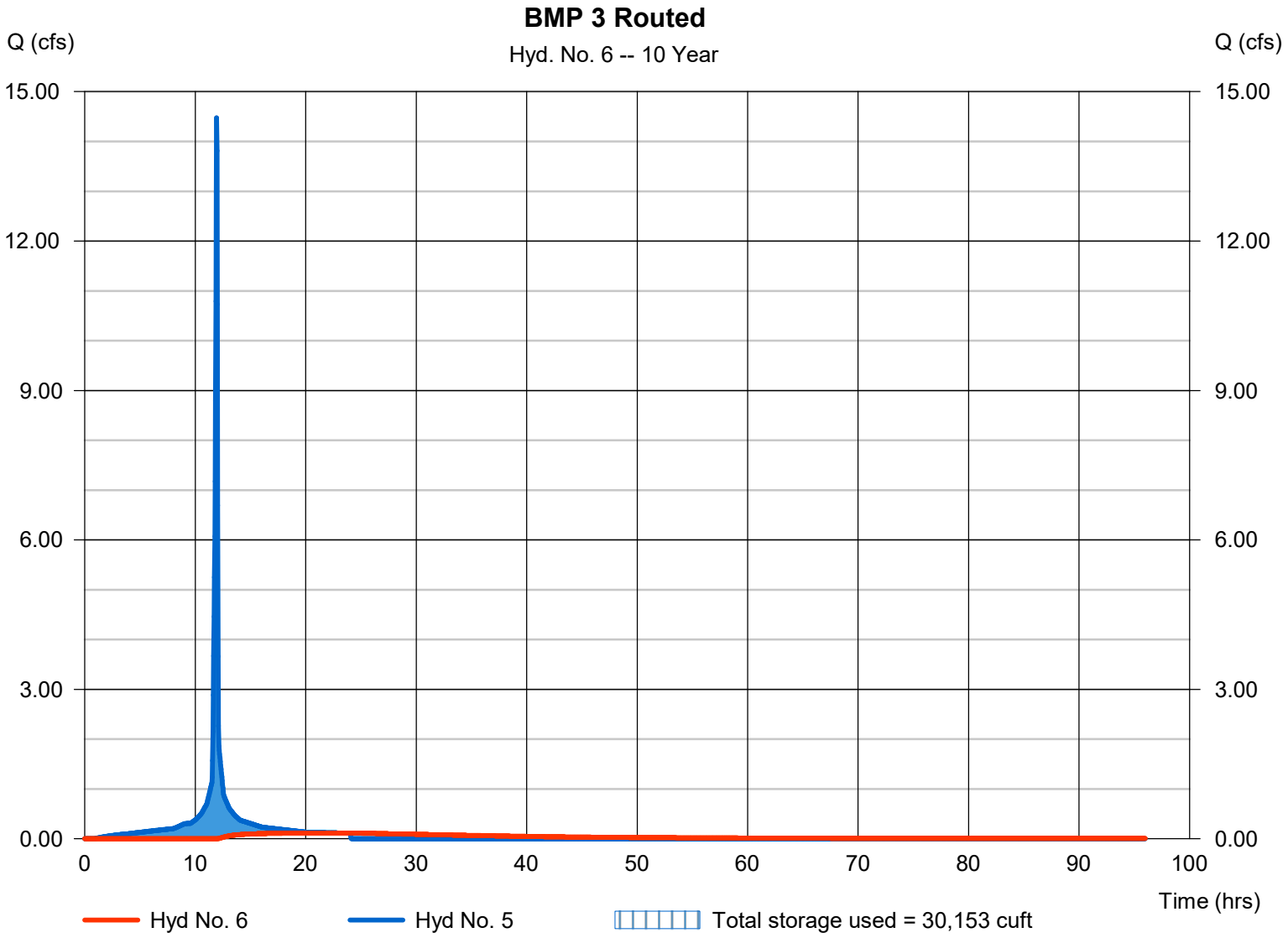
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.116 cfs
Storm frequency	= 10 yrs	Time to peak	= 22.97 hrs
Time interval	= 2 min	Hyd. volume	= 11,796 cuft
Inflow hyd. No.	= 5 - BMP 3 IN	Max. Elevation	= 321.37 ft
Reservoir name	= BMP 3	Max. Storage	= 30,153 cuft

Storage Indication method used.



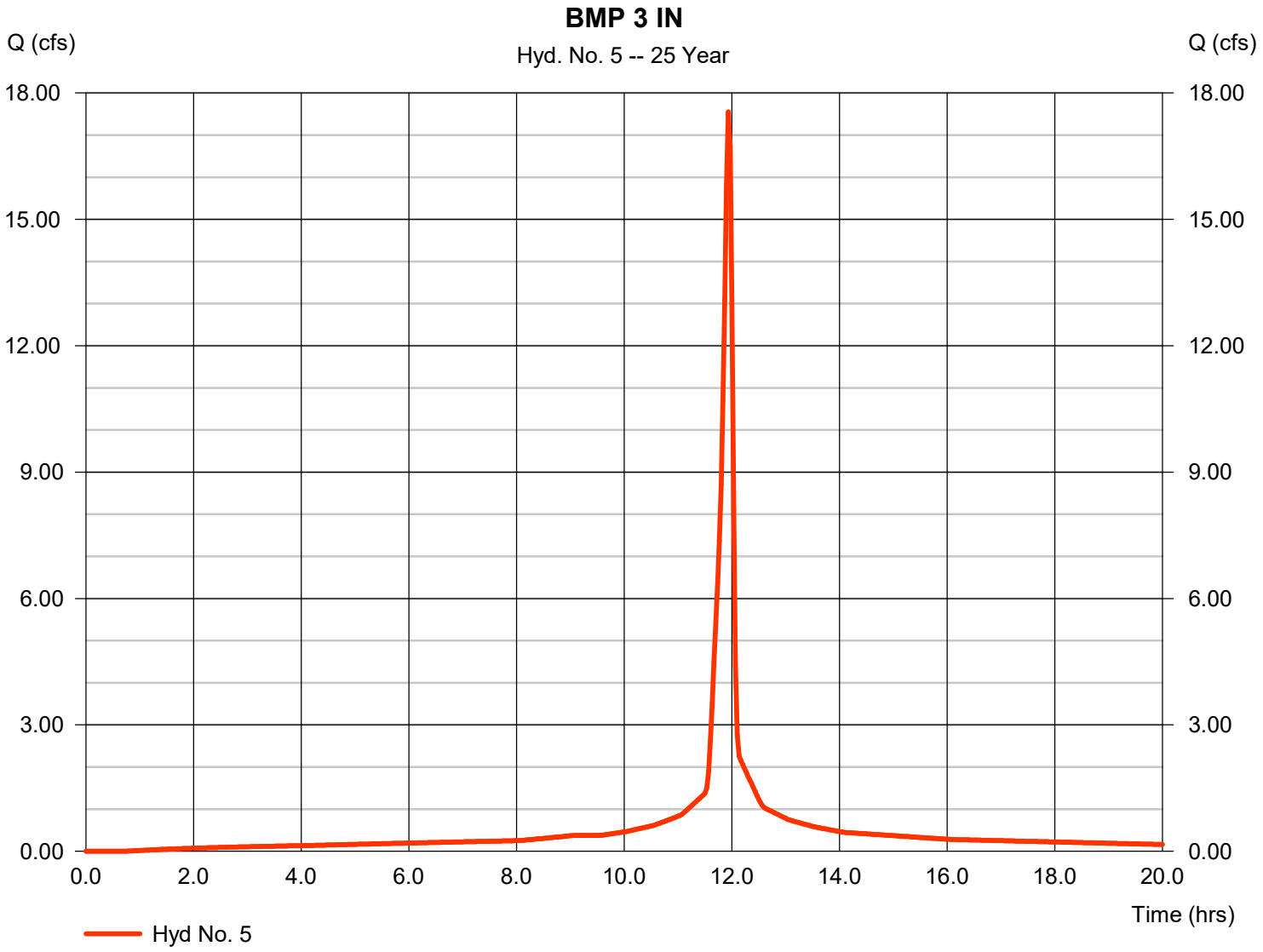
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

BMP 3 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.55 cfs
Storm frequency	=	25 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	42,097 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

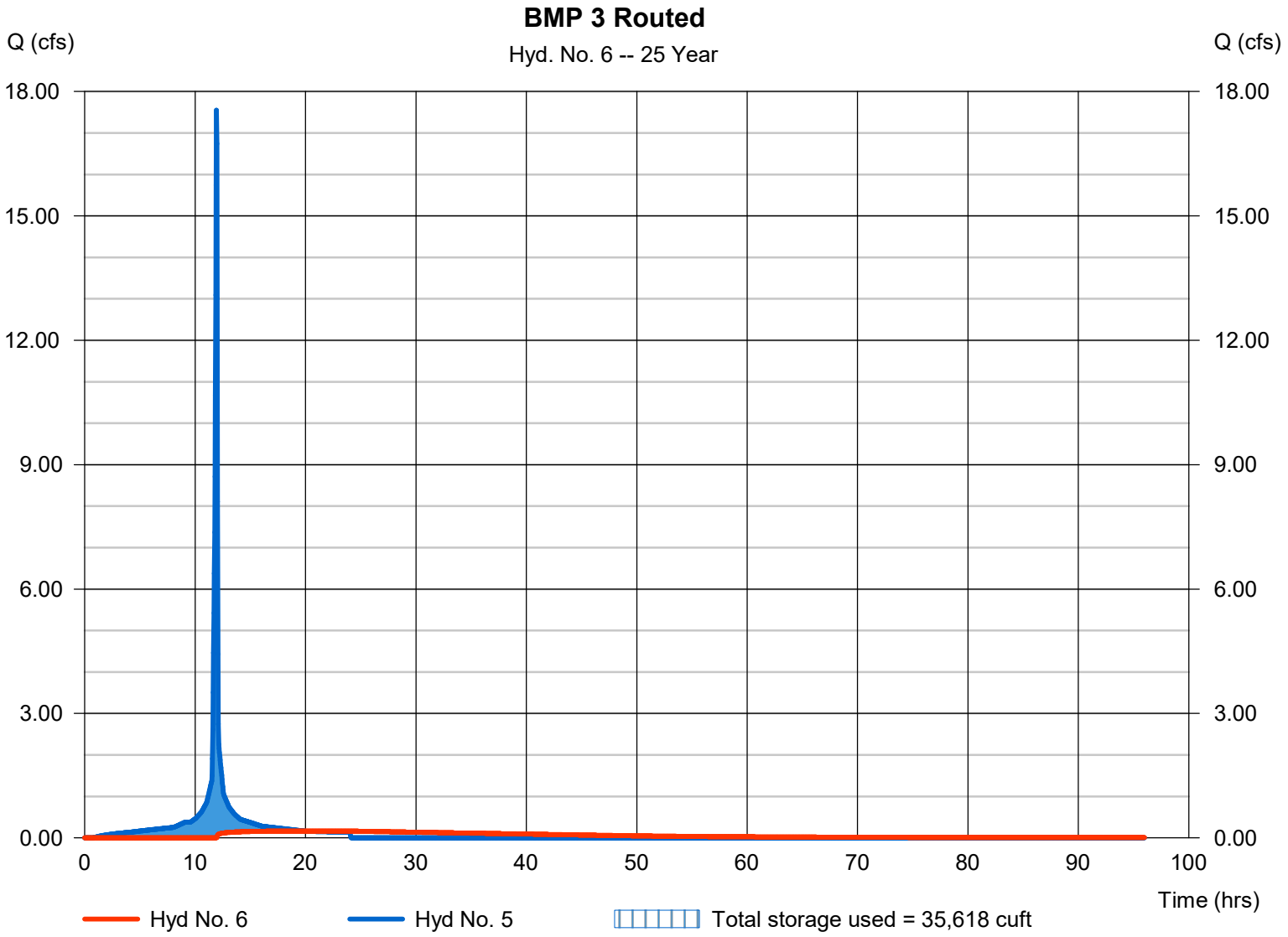
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.165 cfs
Storm frequency	=	25 yrs	Time to peak	=	19.83 hrs
Time interval	=	2 min	Hyd. volume	=	19,215 cuft
Inflow hyd. No.	=	5 - BMP 3 IN	Max. Elevation	=	321.61 ft
Reservoir name	=	BMP 3	Max. Storage	=	35,618 cuft

Storage Indication method used.



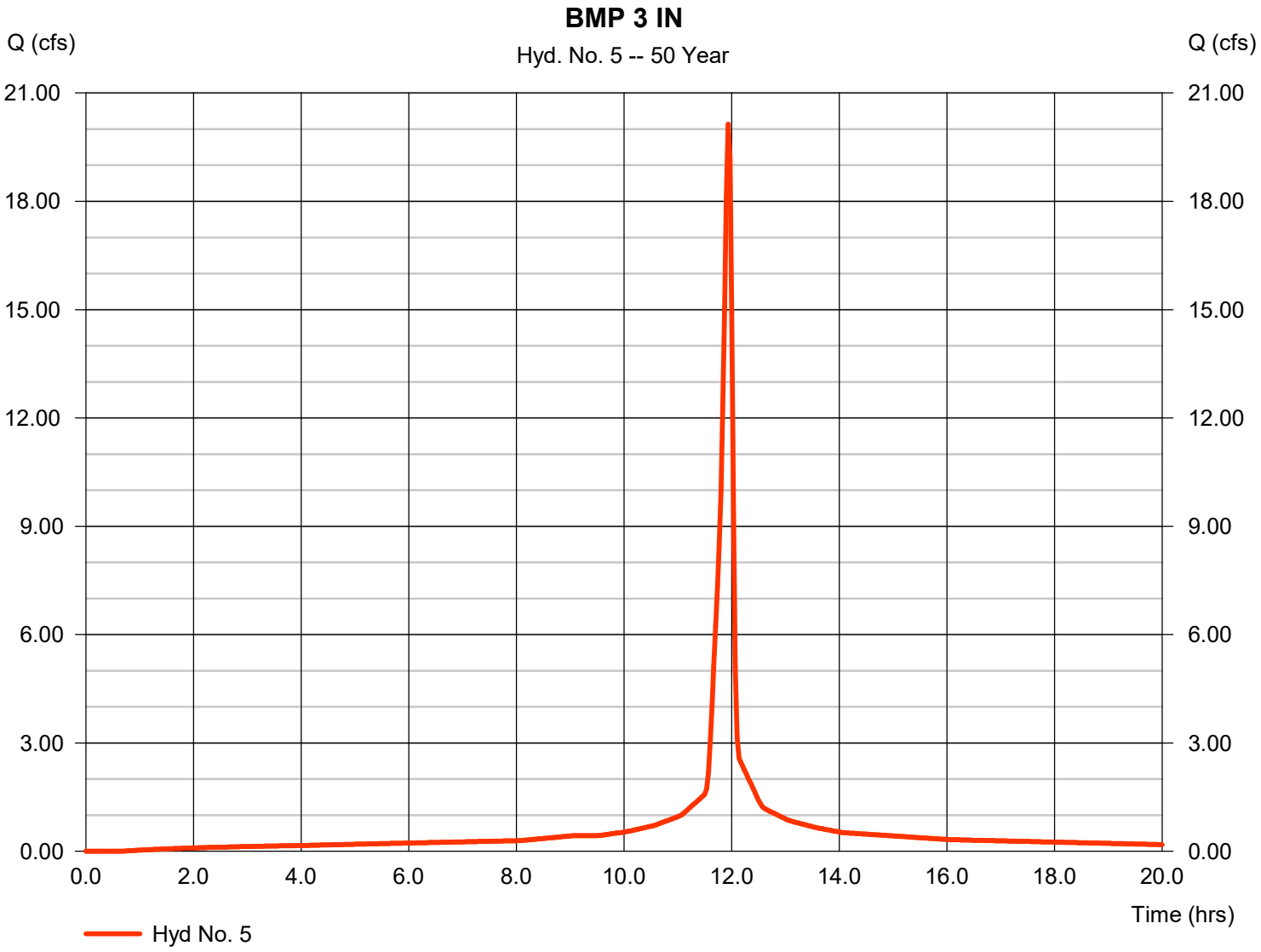
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

BMP 3 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	20.14 cfs
Storm frequency	=	50 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	48,512 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

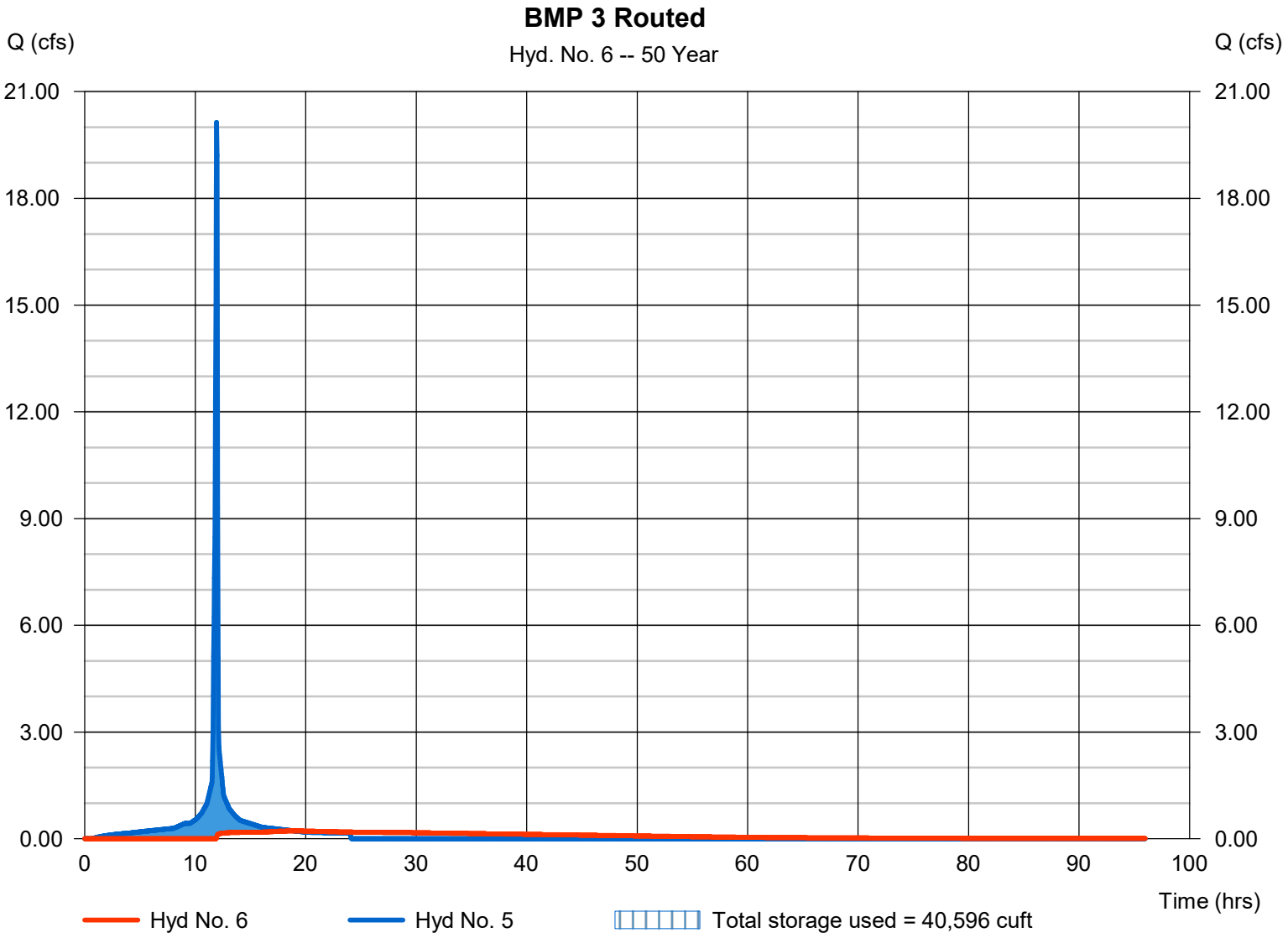
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.219 cfs
Storm frequency	= 50 yrs	Time to peak	= 19.00 hrs
Time interval	= 2 min	Hyd. volume	= 25,455 cuft
Inflow hyd. No.	= 5 - BMP 3 IN	Max. Elevation	= 321.76 ft
Reservoir name	= BMP 3	Max. Storage	= 40,596 cuft

Storage Indication method used.



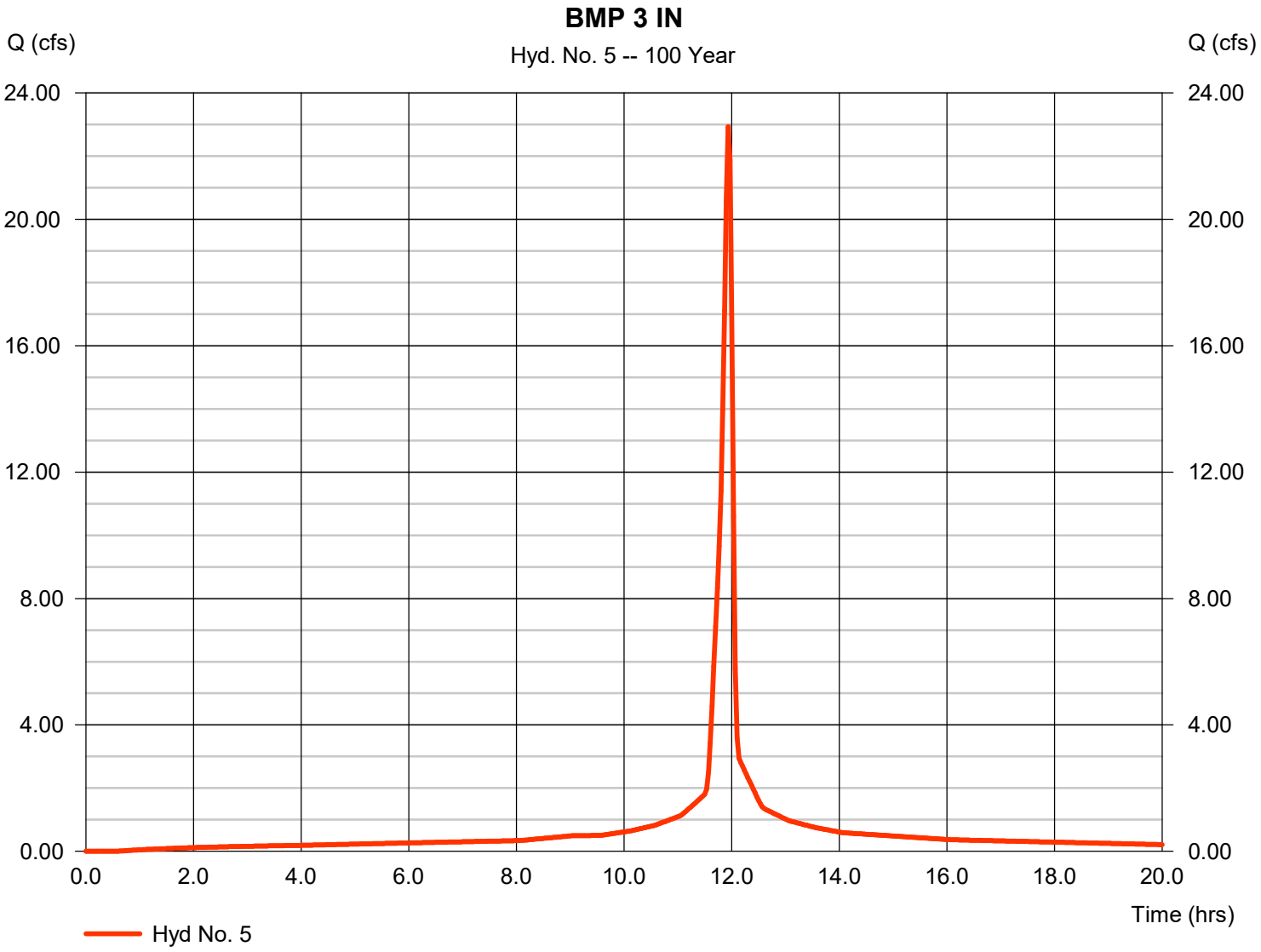
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 5

BMP 3 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.94 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	55,457 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

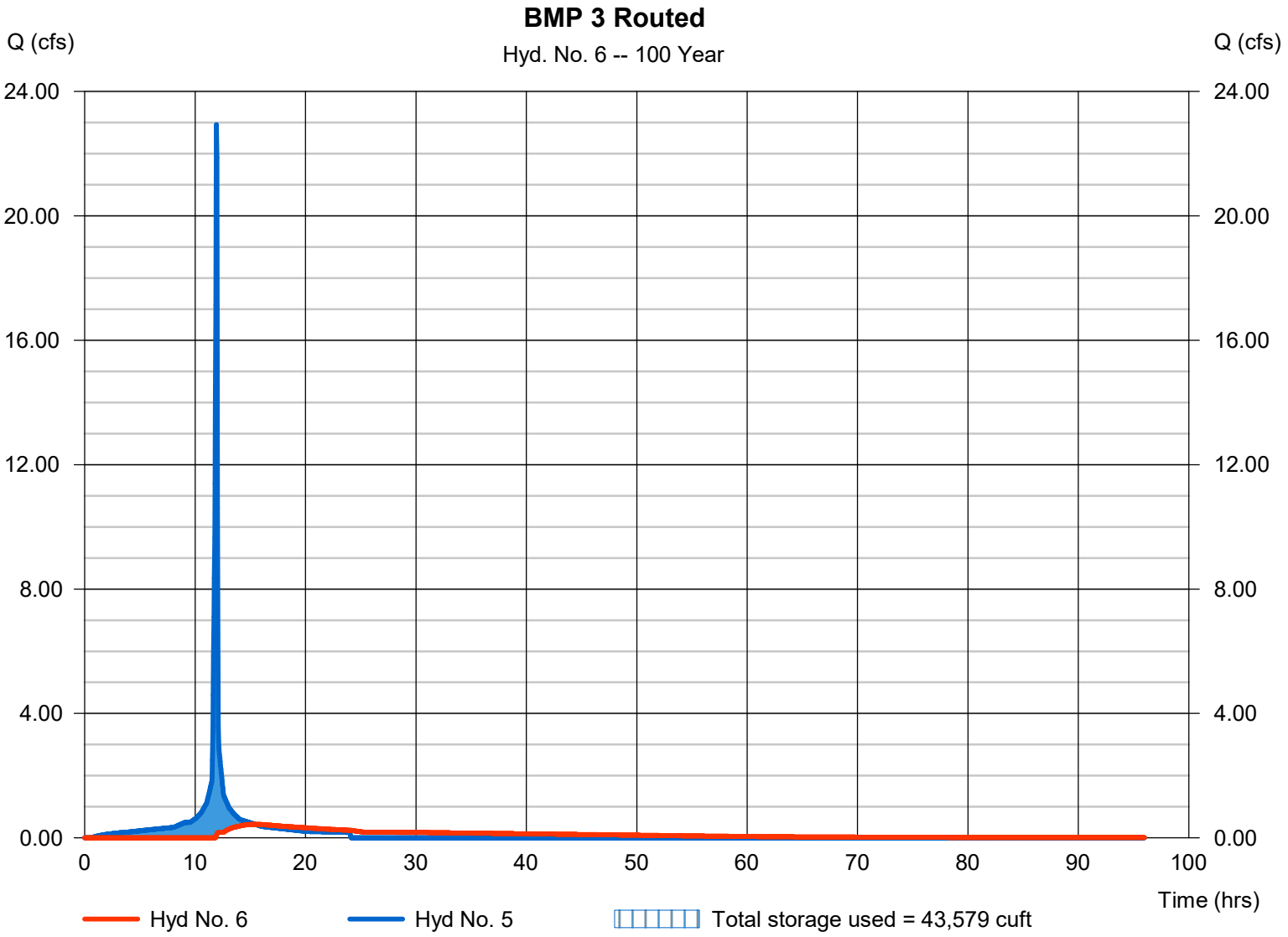
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 6

BMP 3 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.435 cfs
Storm frequency	= 100 yrs	Time to peak	= 15.43 hrs
Time interval	= 2 min	Hyd. volume	= 32,369 cuft
Inflow hyd. No.	= 5 - BMP 3 IN	Max. Elevation	= 321.84 ft
Reservoir name	= BMP 3	Max. Storage	= 43,579 cuft

Storage Indication method used.



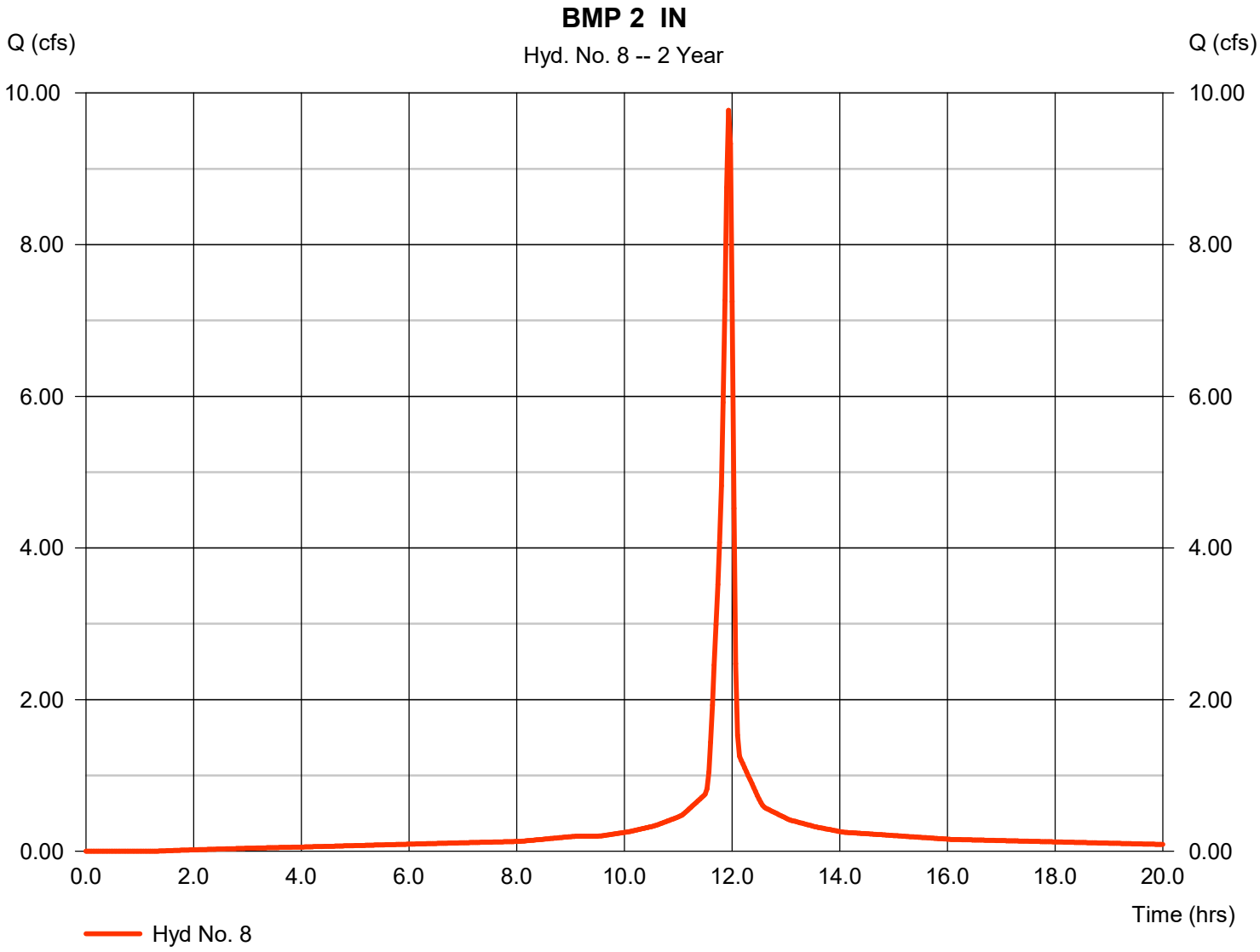
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.771 cfs
Storm frequency	=	2 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	22,871 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

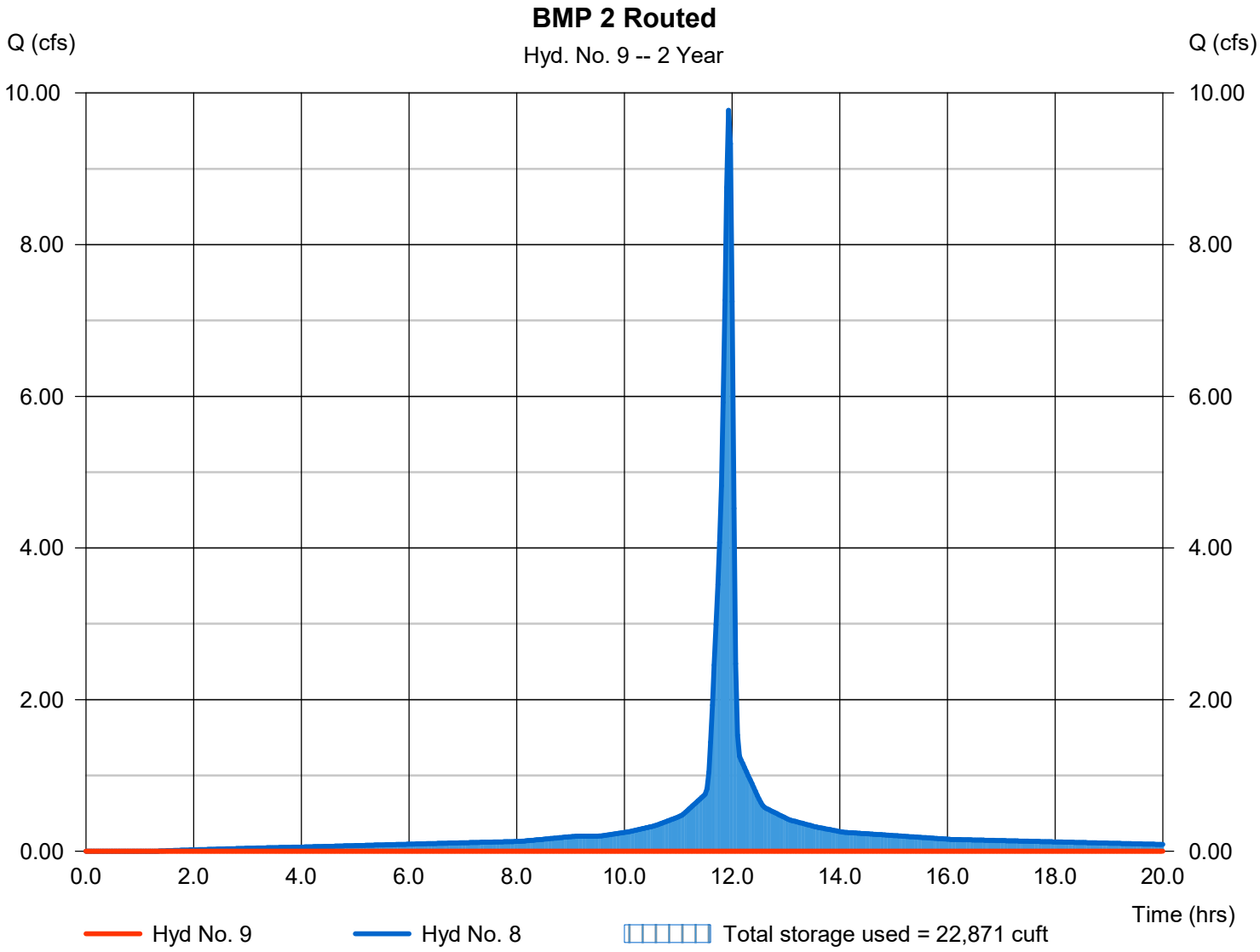
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 8 - BMP 2 IN	Max. Elevation	= 316.75 ft
Reservoir name	= BMP 2	Max. Storage	= 22,871 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Pond No. 6 - BMP 2

Pond Data

Pond storage is based on user-defined values.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	316.00	n/a	0	0
0.67	316.67	n/a	20,294	20,294
0.75	316.75	n/a	2,741	23,035
1.50	317.50	n/a	28,665	51,700

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 15.00	0.00	0.00	0.00
Span (in)	= 15.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 312.50	0.00	0.00	0.00
Length (ft)	= 84.00	0.00	0.00	0.00
Slope (%)	= 0.53	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

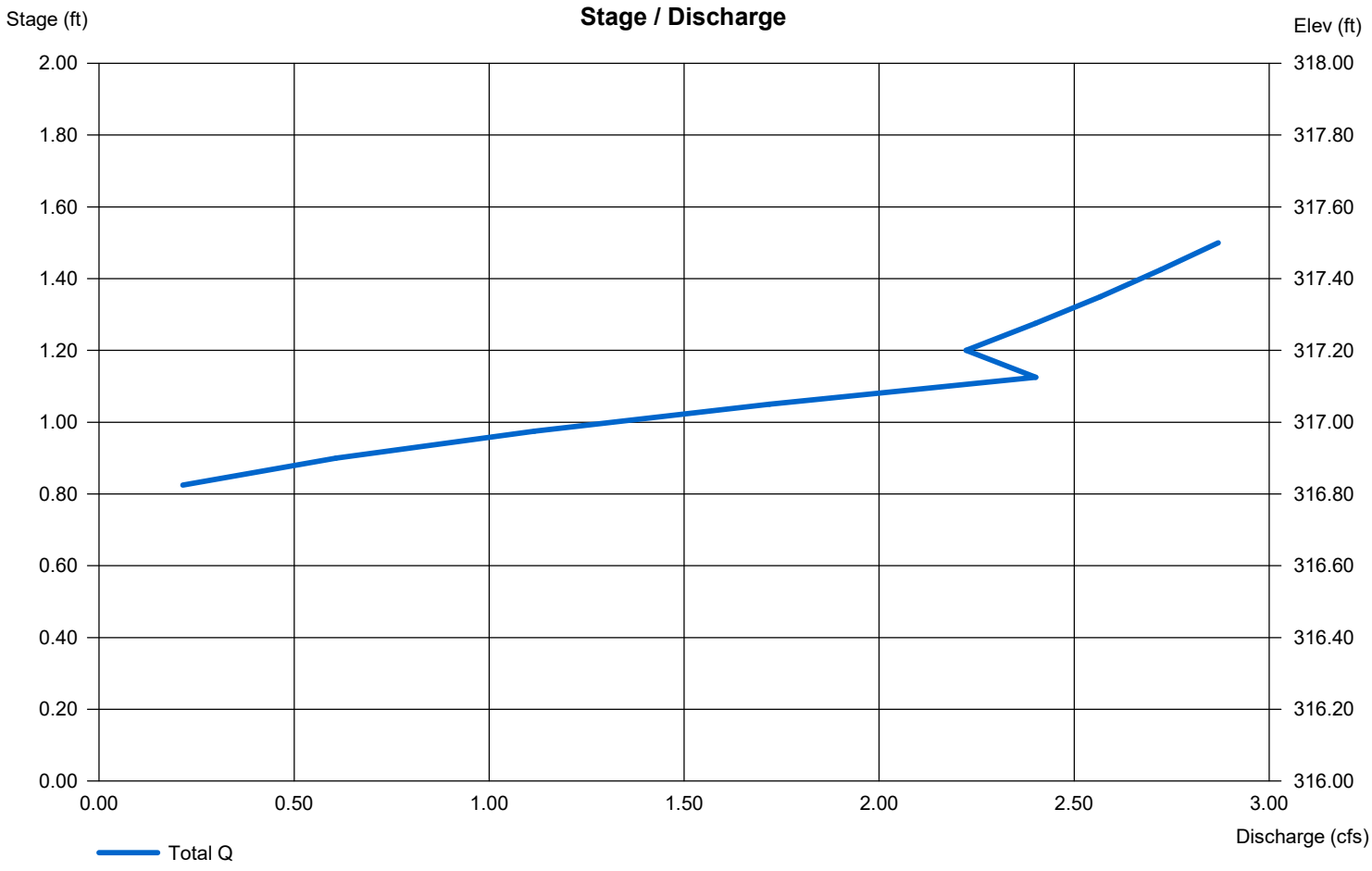
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	0.00	0.00	0.00
Crest El. (ft)	= 316.75	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



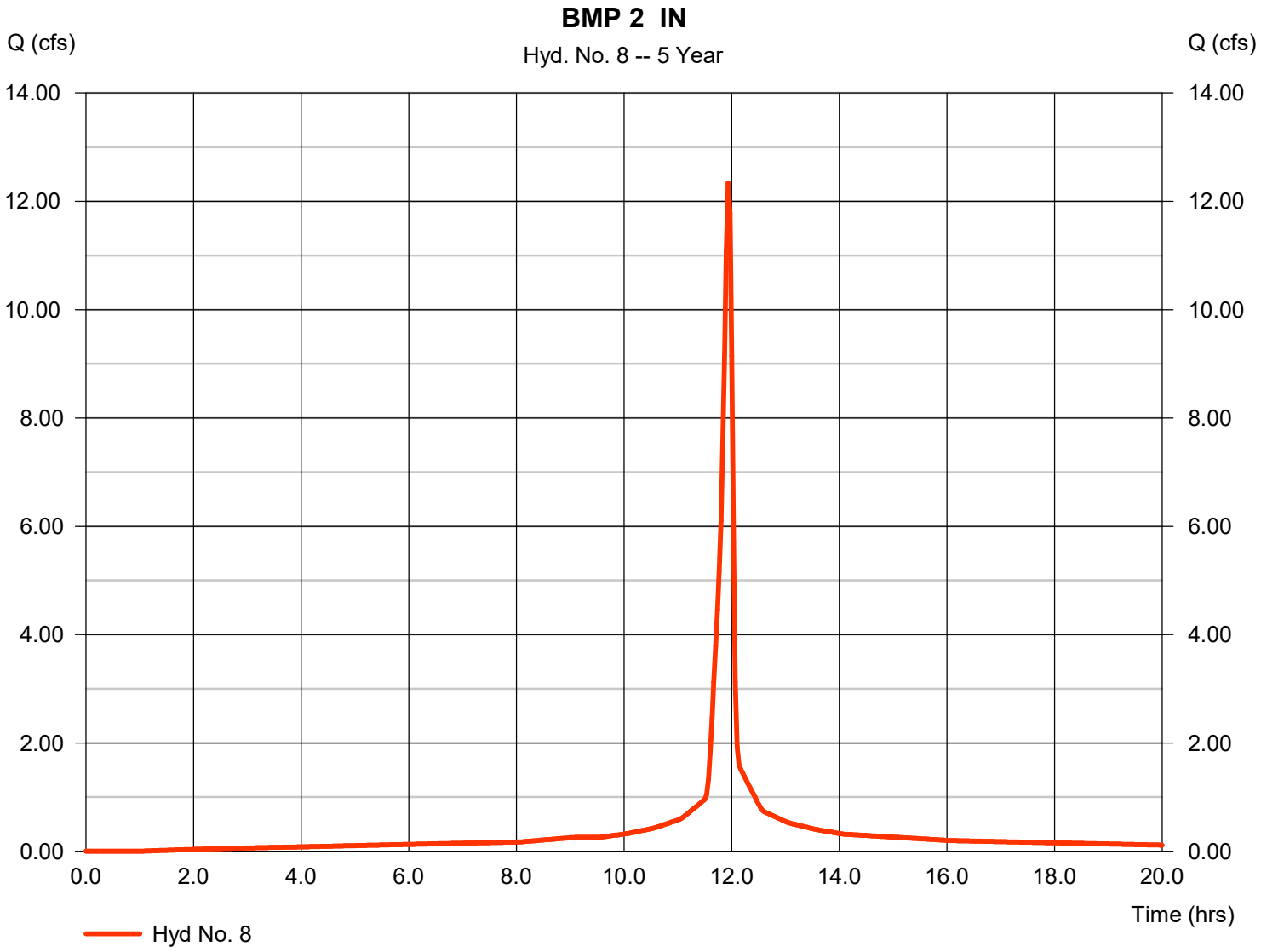
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	12.34 cfs
Storm frequency	=	5 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	29,199 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

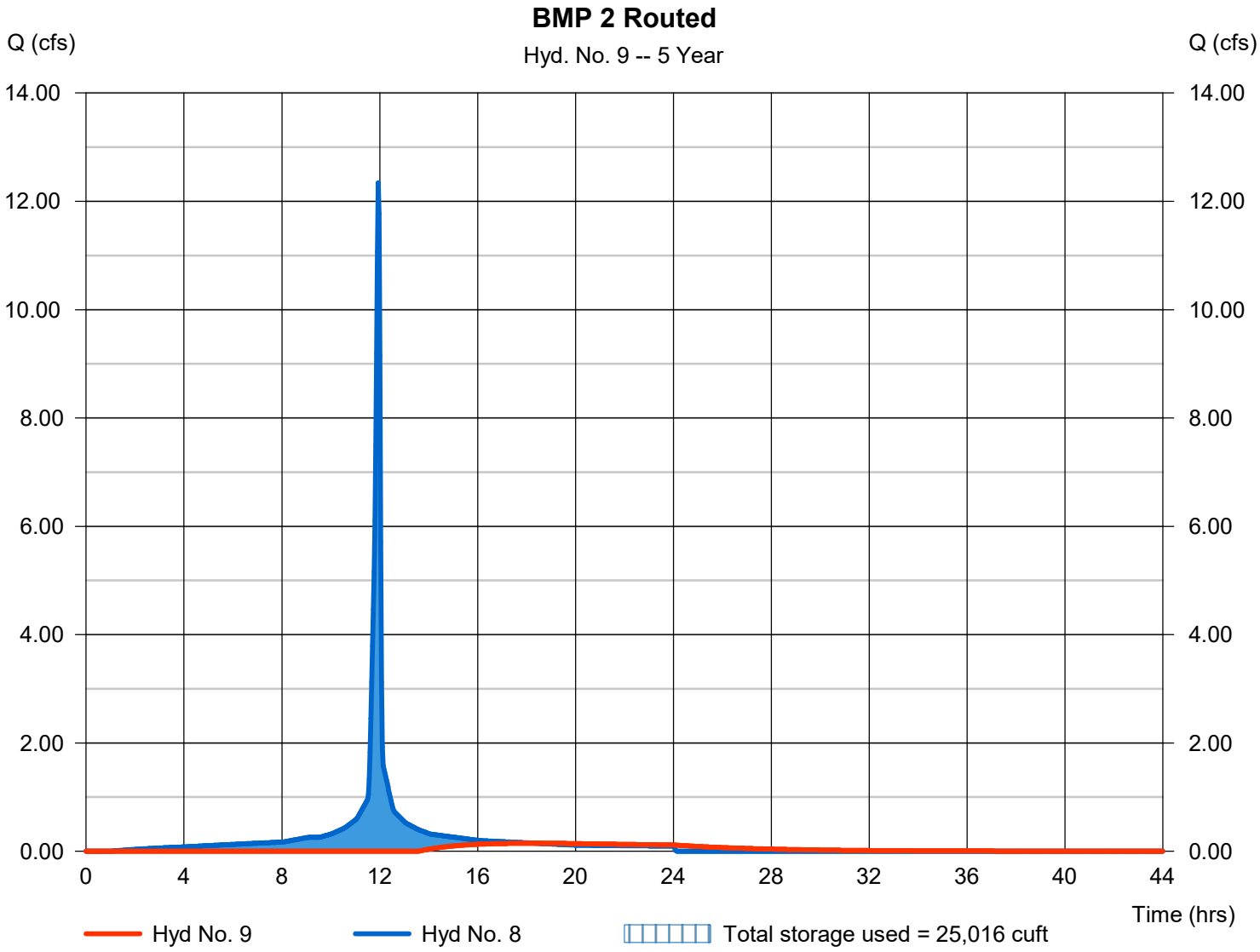
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.148 cfs
Storm frequency	= 5 yrs	Time to peak	= 18.33 hrs
Time interval	= 2 min	Hyd. volume	= 6,151 cuft
Inflow hyd. No.	= 8 - BMP 2 IN	Max. Elevation	= 316.80 ft
Reservoir name	= BMP 2	Max. Storage	= 25,016 cuft

Storage Indication method used.



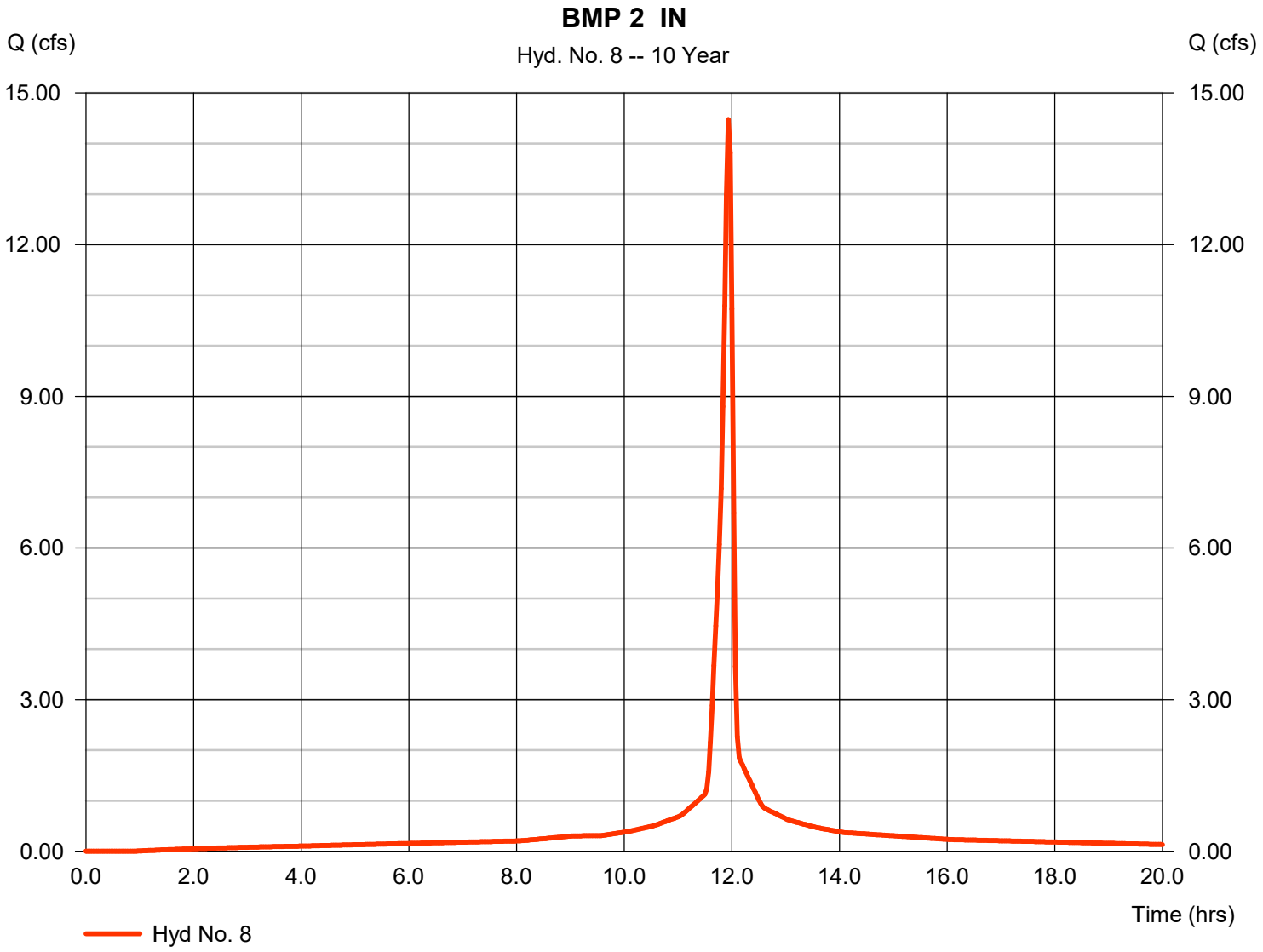
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.48 cfs
Storm frequency	=	10 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	34,477 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

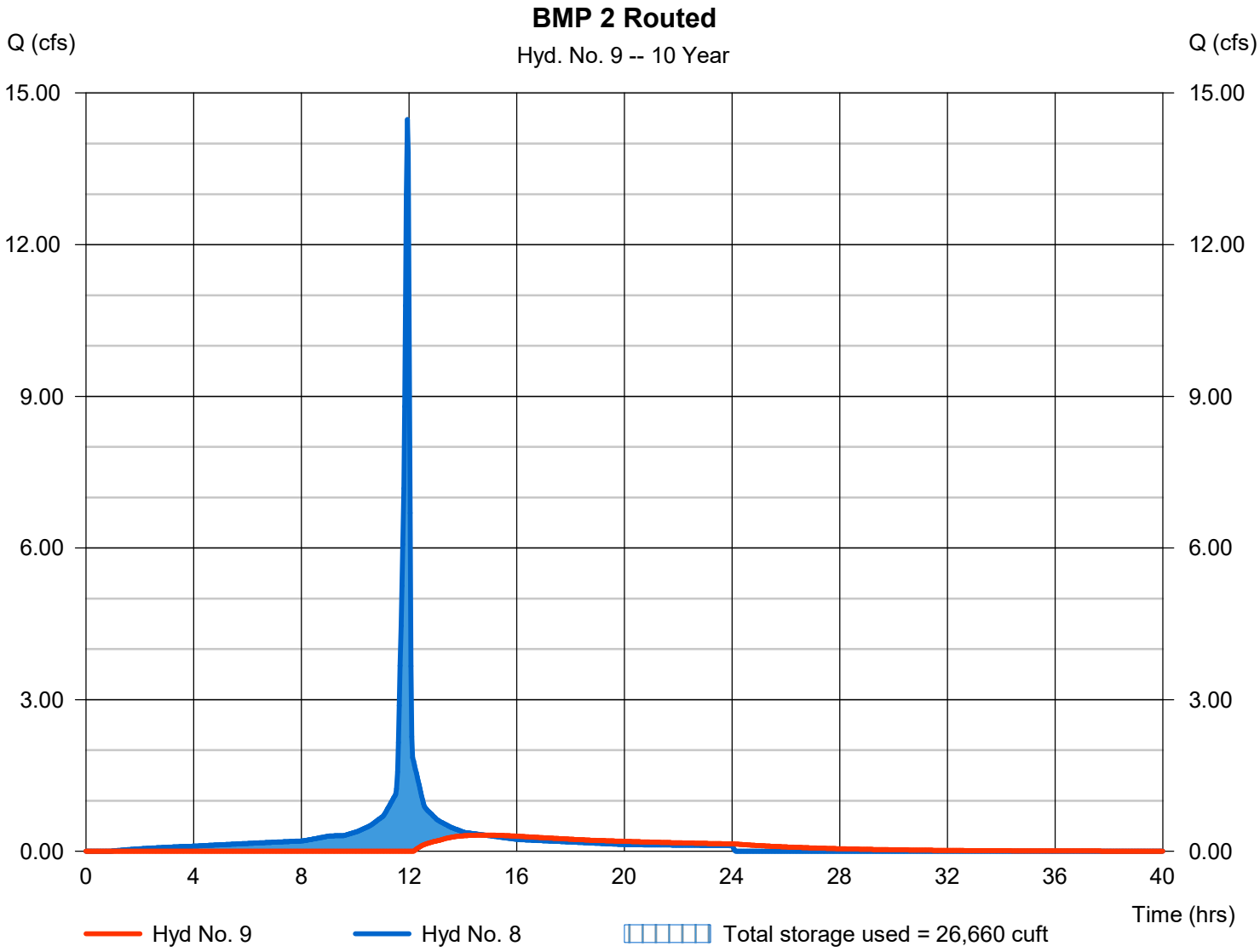
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	= Reservoir	Peak discharge	= 0.319 cfs
Storm frequency	= 10 yrs	Time to peak	= 14.80 hrs
Time interval	= 2 min	Hyd. volume	= 11,429 cuft
Inflow hyd. No.	= 8 - BMP 2 IN	Max. Elevation	= 316.84 ft
Reservoir name	= BMP 2	Max. Storage	= 26,660 cuft

Storage Indication method used.



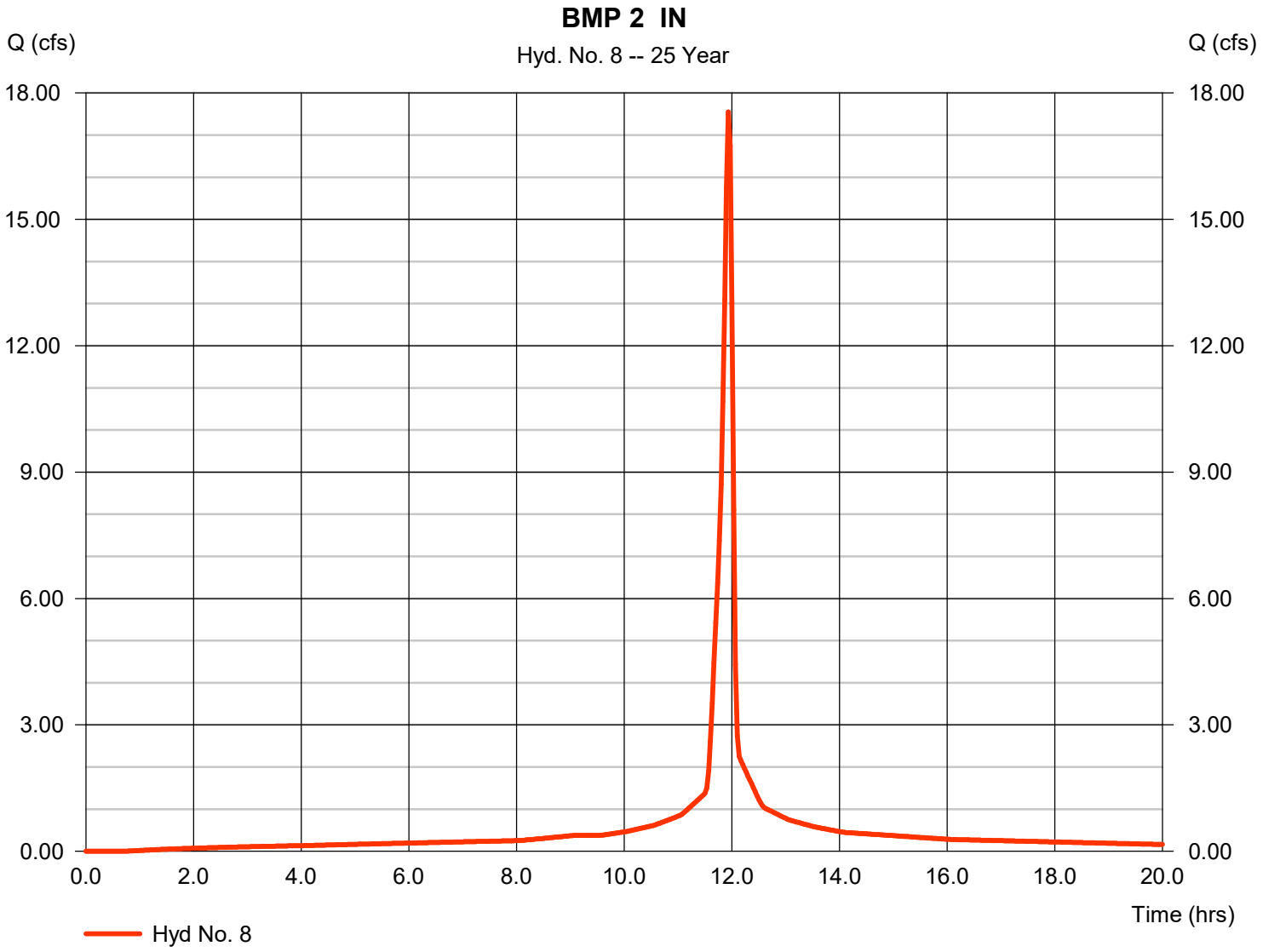
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.55 cfs
Storm frequency	=	25 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	42,097 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

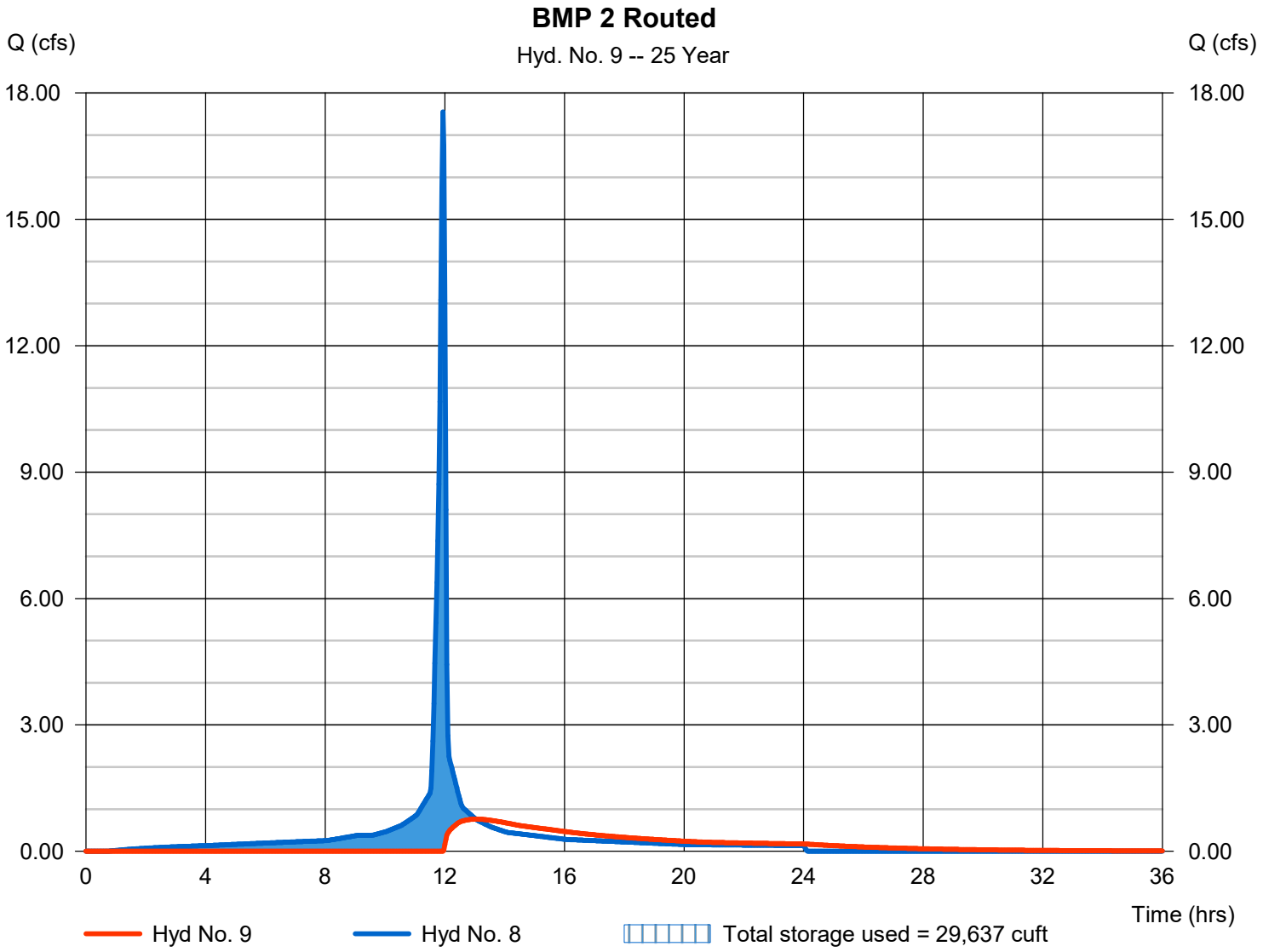
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.762 cfs
Storm frequency	=	25 yrs	Time to peak	=	13.03 hrs
Time interval	=	2 min	Hyd. volume	=	19,048 cuft
Inflow hyd. No.	=	8 - BMP 2 IN	Max. Elevation	=	316.92 ft
Reservoir name	=	BMP 2	Max. Storage	=	29,637 cuft

Storage Indication method used.



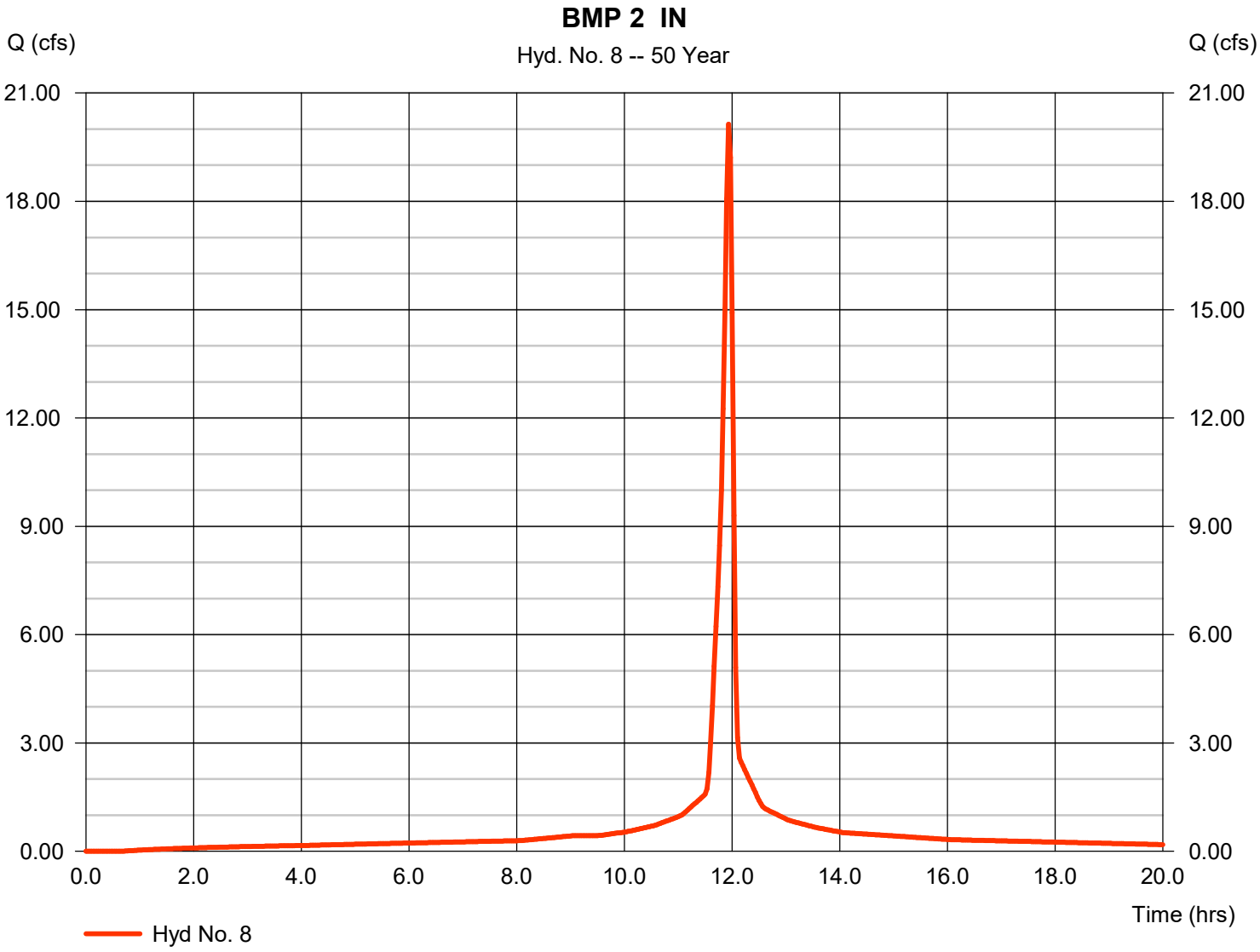
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	20.14 cfs
Storm frequency	=	50 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	48,512 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

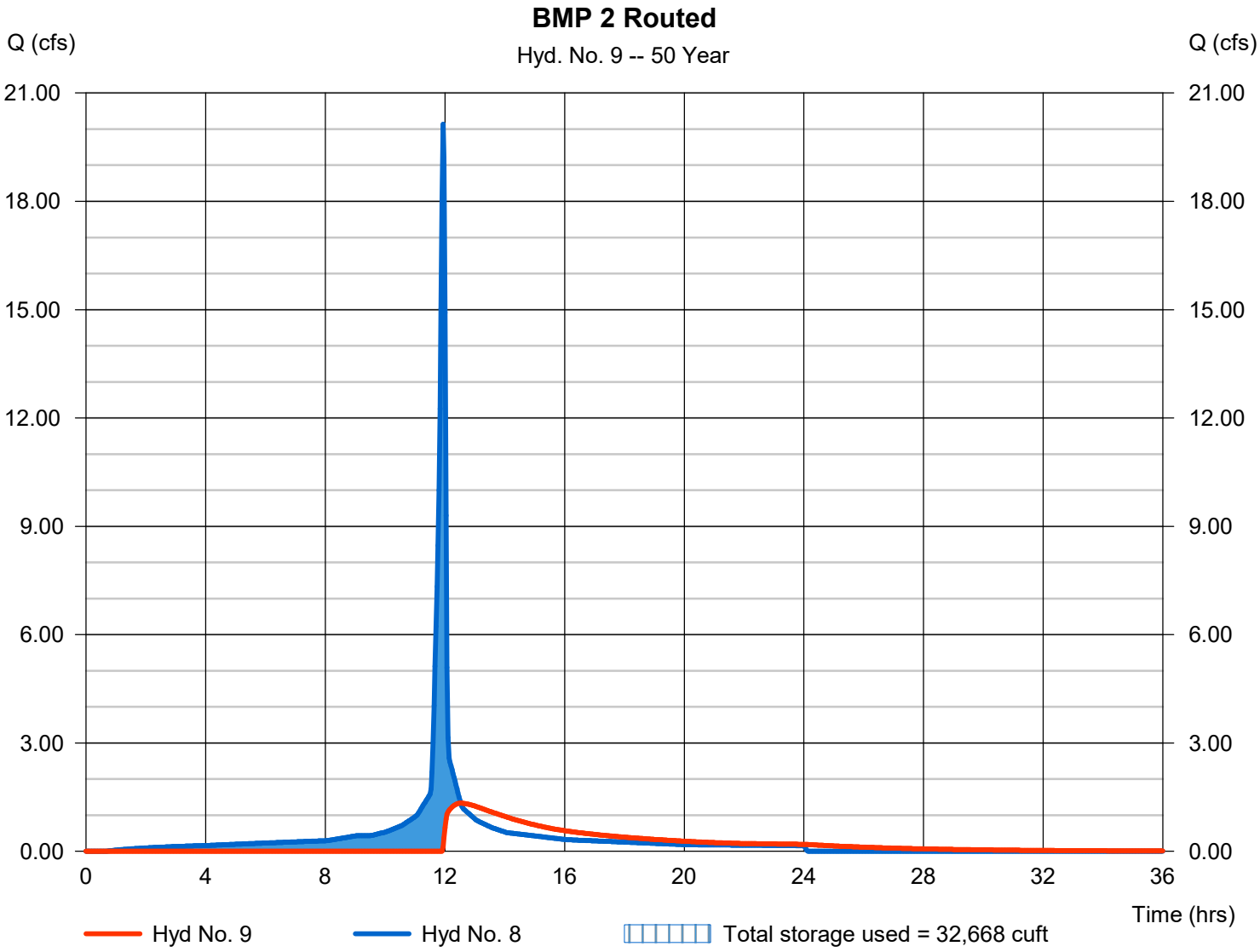
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	1.333 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.53 hrs
Time interval	=	2 min	Hyd. volume	=	25,463 cuft
Inflow hyd. No.	=	8 - BMP 2 IN	Max. Elevation	=	317.00 ft
Reservoir name	=	BMP 2	Max. Storage	=	32,668 cuft

Storage Indication method used.

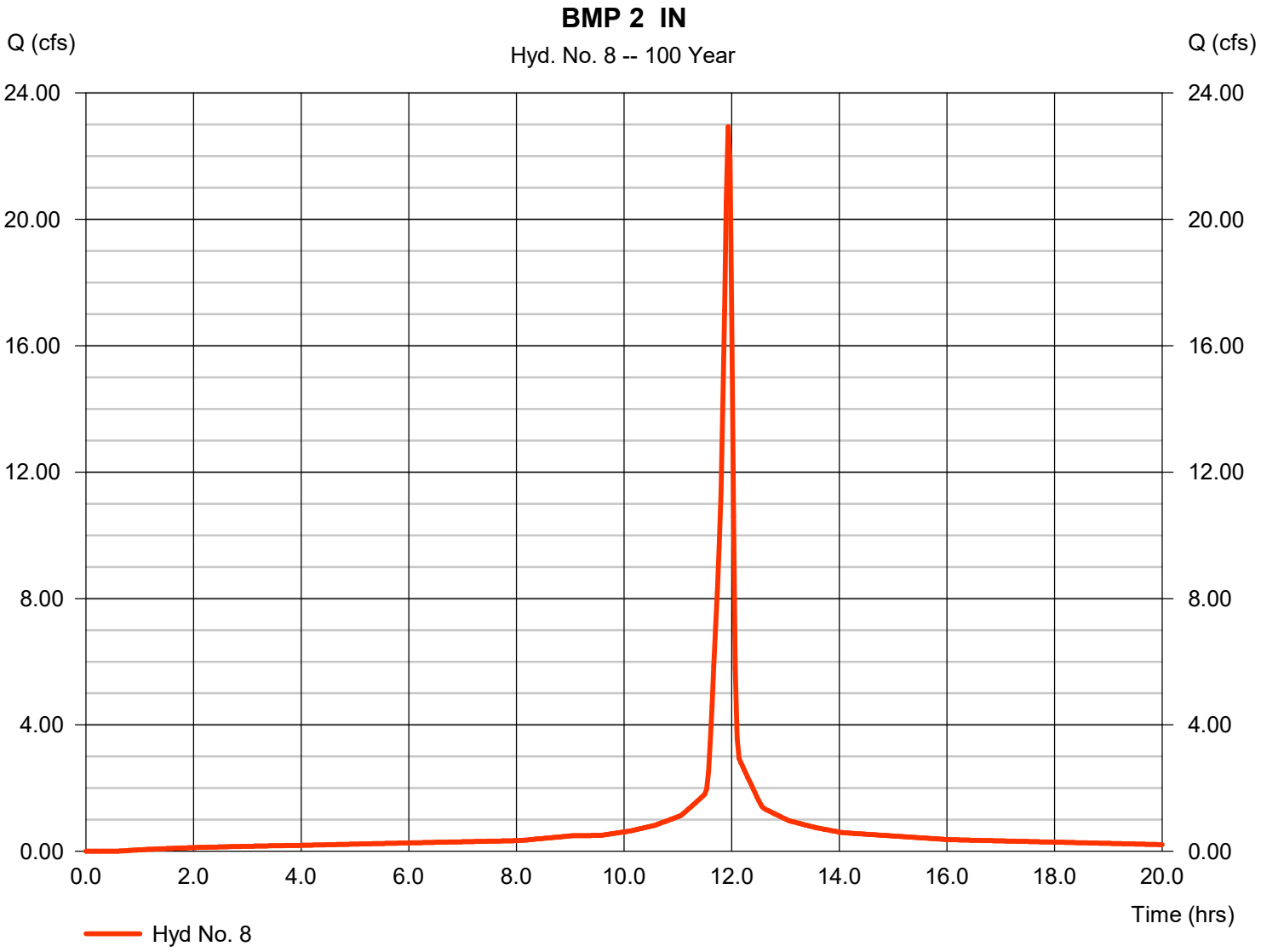


Hydrograph Report

Hyd. No. 8

BMP 2 IN

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.94 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.93 hrs
Time interval	=	2 min	Hyd. volume	=	55,457 cuft
Drainage area	=	2.220 ac	Curve number	=	98
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



Hydrograph Report

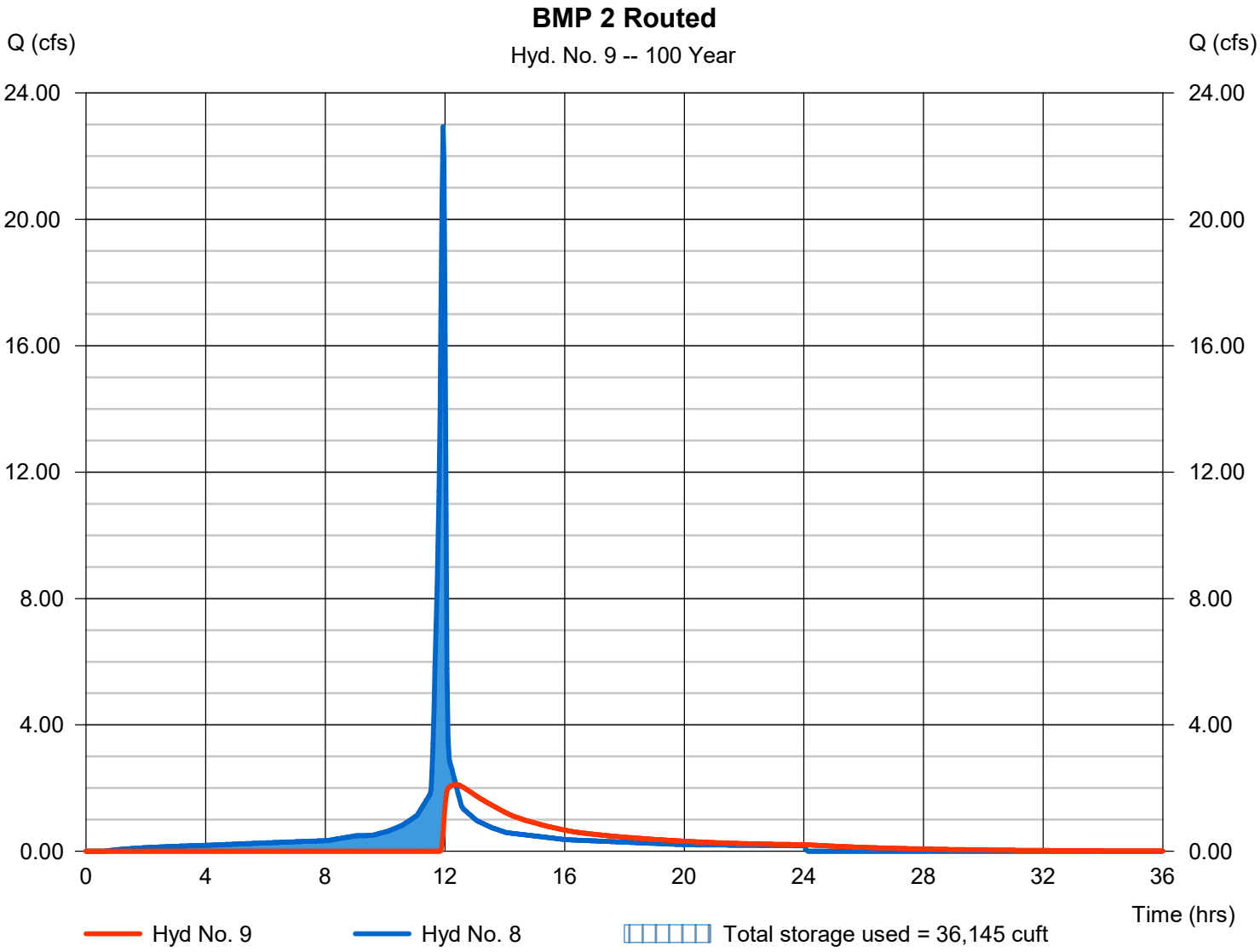
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 9

BMP 2 Routed

Hydrograph type	= Reservoir	Peak discharge	= 2.110 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.37 hrs
Time interval	= 2 min	Hyd. volume	= 32,409 cuft
Inflow hyd. No.	= 8 - BMP 2 IN	Max. Elevation	= 317.09 ft
Reservoir name	= BMP 2	Max. Storage	= 36,145 cuft

Storage Indication method used.



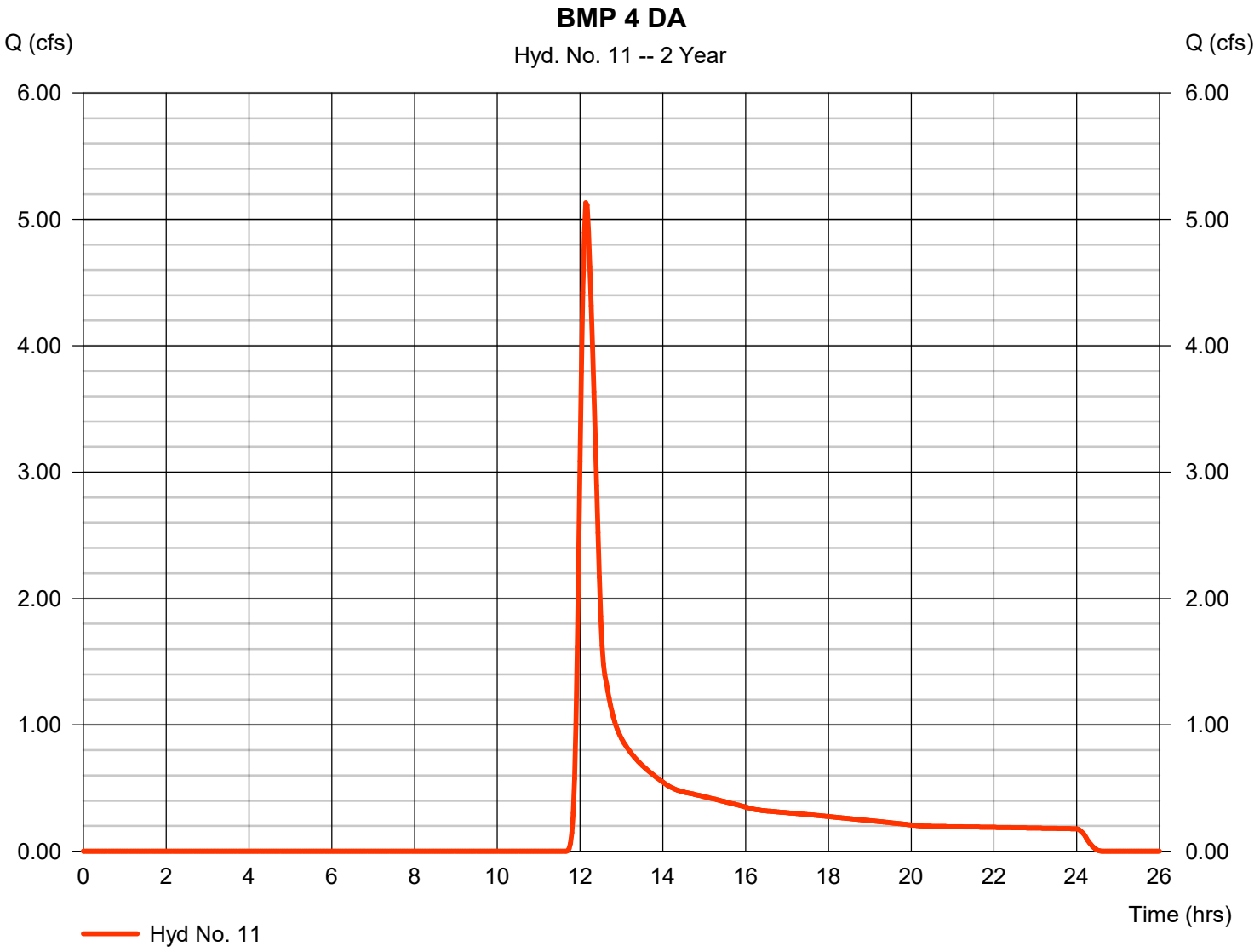
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.132 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	22,498 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



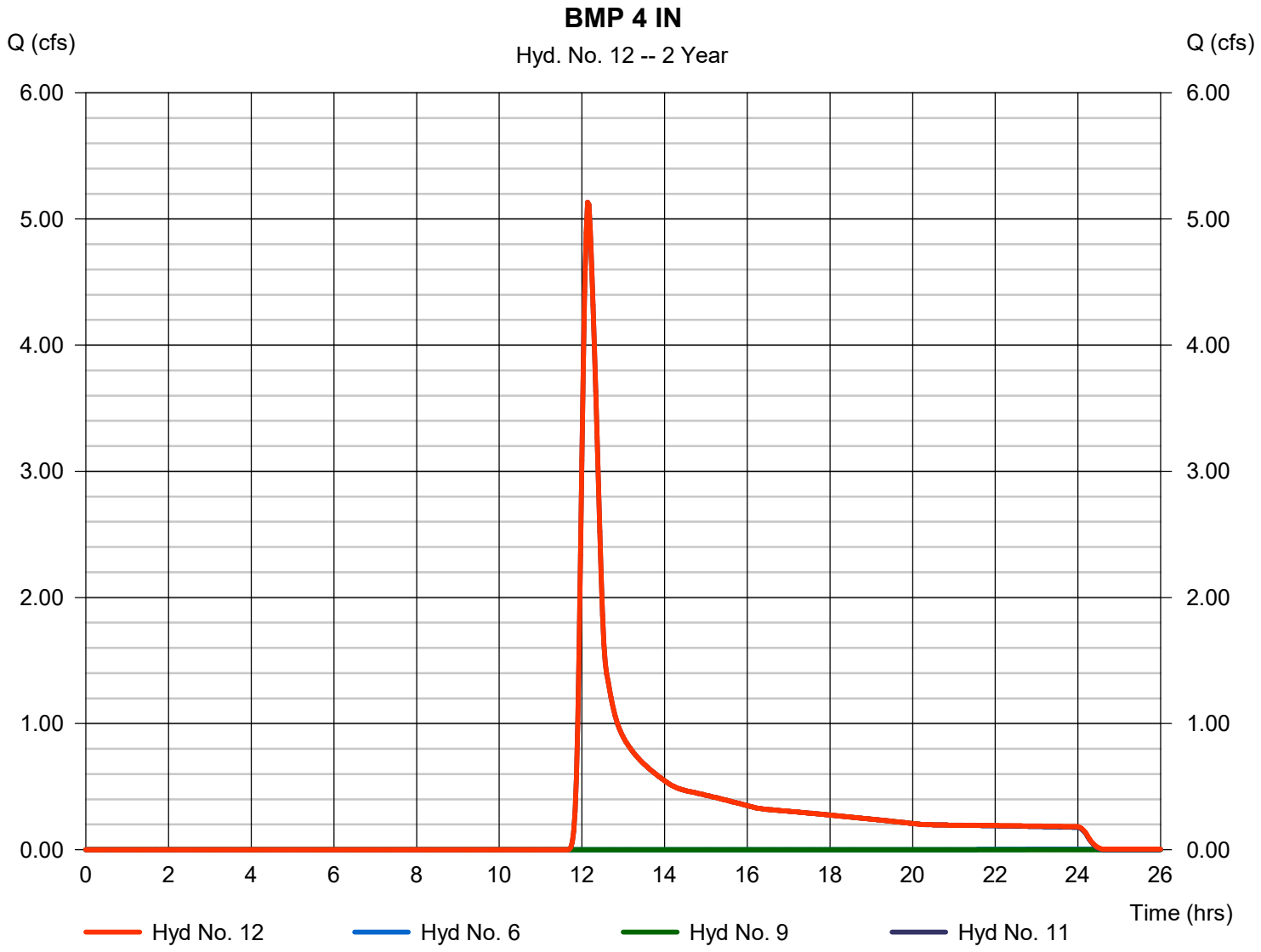
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 12

BMP 4 IN

Hydrograph type	= Combine	Peak discharge	= 5.132 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 23,271 cuft
Inflow hyds.	= 6, 9, 11	Contrib. drain. area	= 9.670 ac



Hydrograph Report

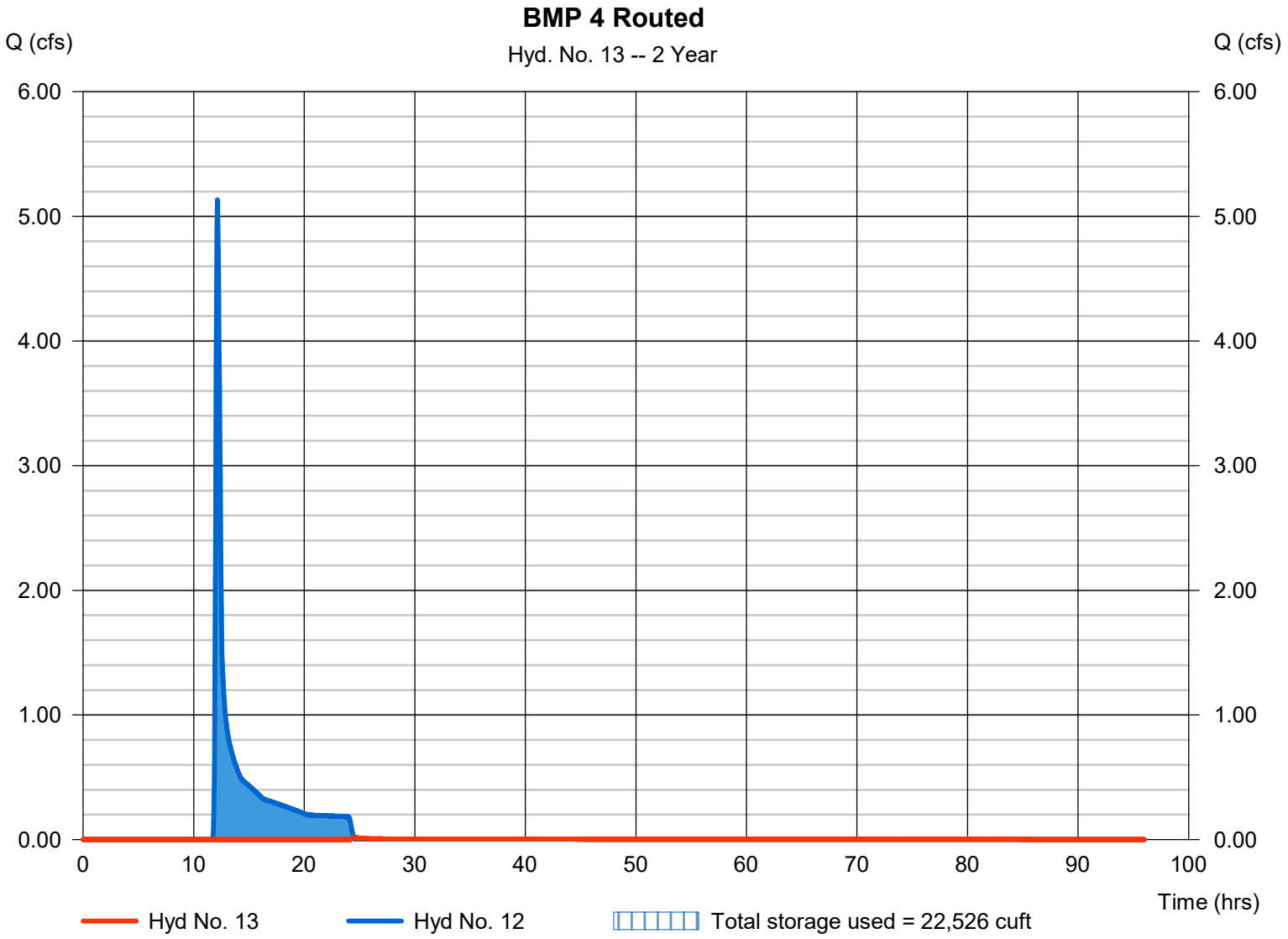
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.019 cfs
Storm frequency	=	2 yrs	Time to peak	=	24.47 hrs
Time interval	=	2 min	Hyd. volume	=	790 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.00 ft
Reservoir name	=	BMP 4	Max. Storage	=	22,526 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Pond No. 5 - BMP 4

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 310.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	310.00	19,809	0	0
1.00	311.00	25,262	22,478	22,478
2.00	312.00	31,631	28,384	50,862
3.00	313.00	39,183	35,336	86,198
4.00	314.00	46,661	42,863	129,062
4.50	314.50	49,481	24,030	153,091
5.00	315.00	52,258	25,429	178,520

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 24.00	0.00	0.00	0.00
Span (in)	= 24.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 307.25	0.00	0.00	0.00
Length (ft)	= 36.00	0.00	0.00	0.00
Slope (%)	= 0.69	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

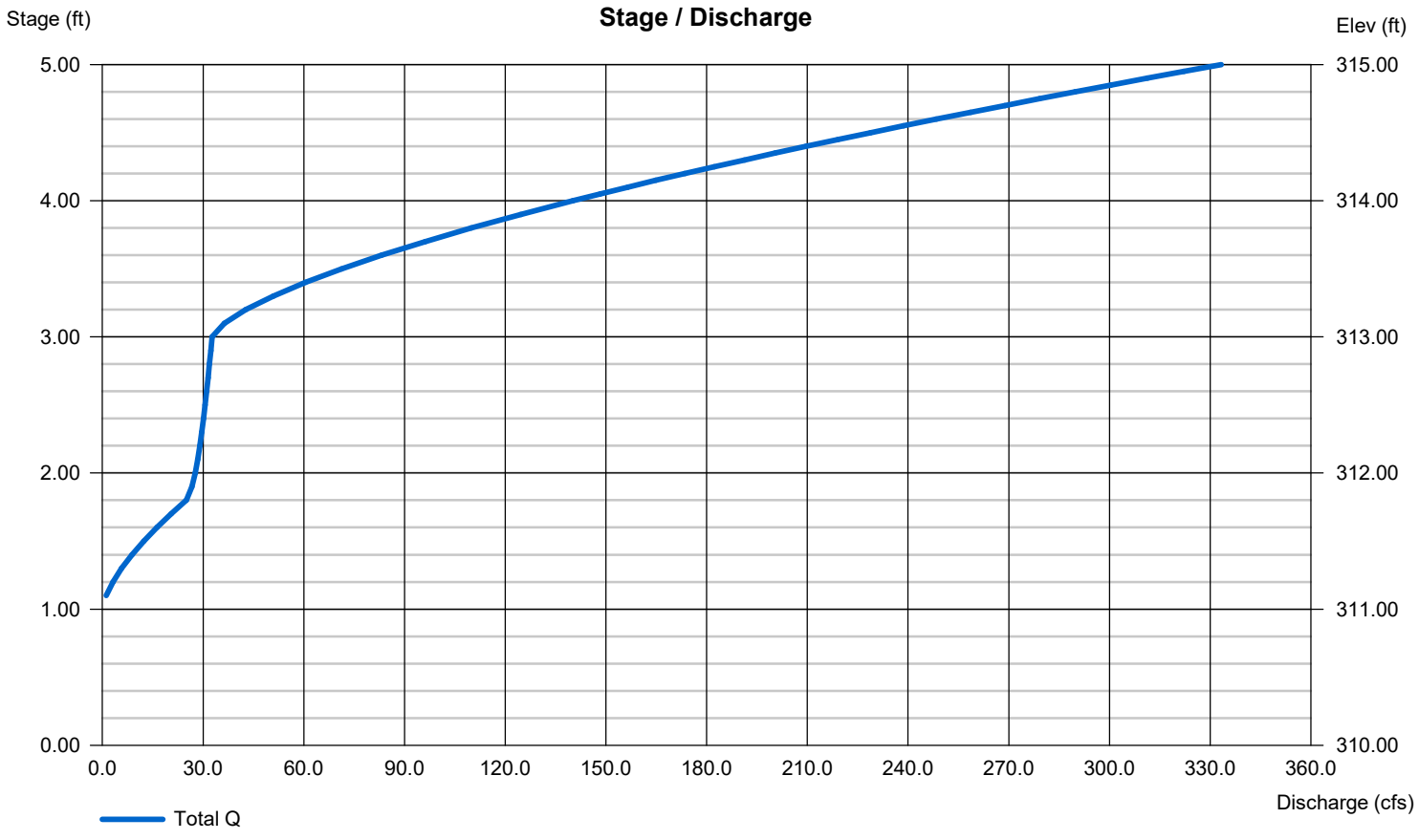
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 10.50	Inactive	40.00	0.00
Crest El. (ft)	= 311.00	311.00	313.00	0.00
Weir Coeff.	= 3.33	3.33	2.60	3.33
Weir Type	= 1	Rect	Broad	---
Multi-Stage	= Yes	Yes	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



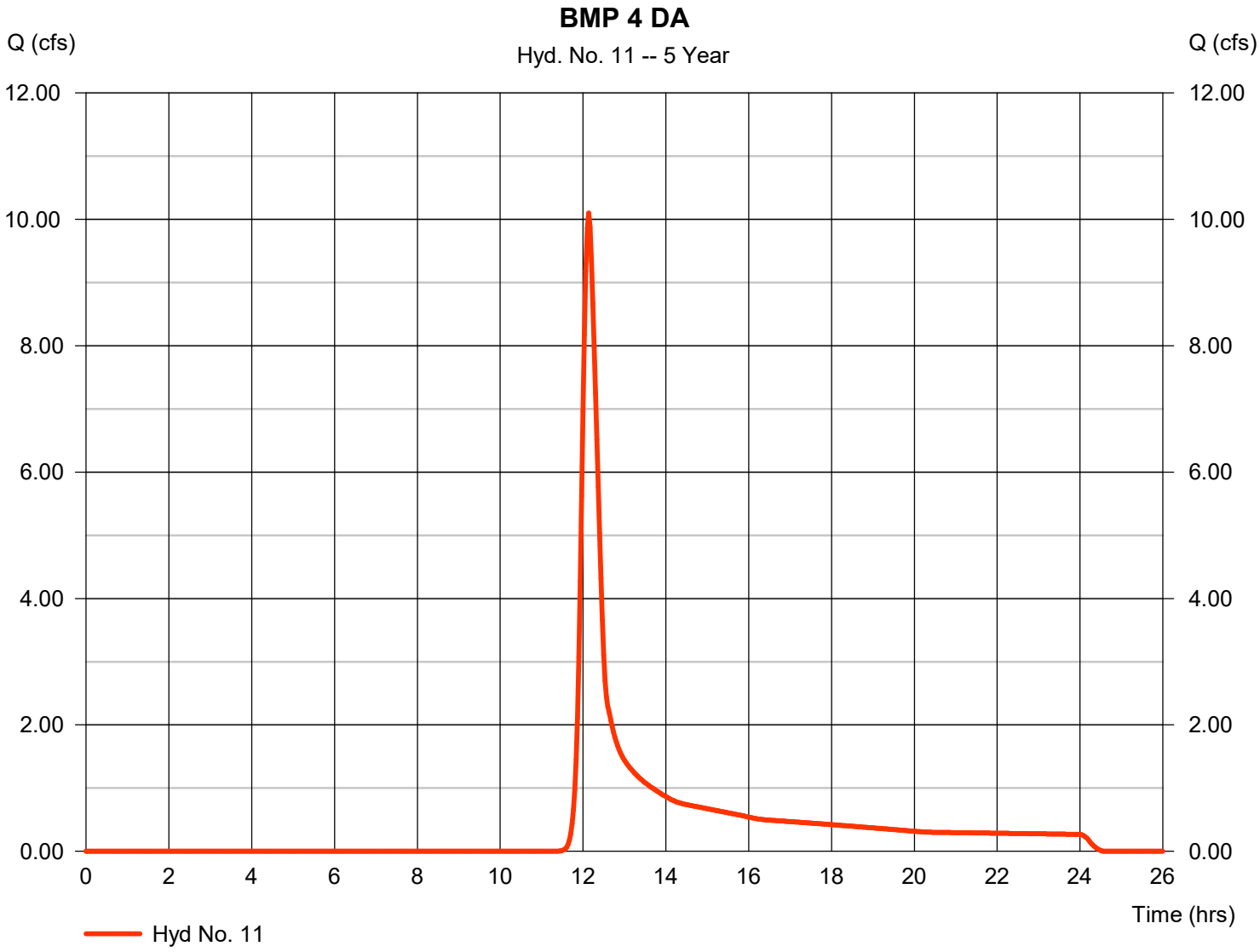
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.10 cfs
Storm frequency	=	5 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	38,836 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	4.10 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



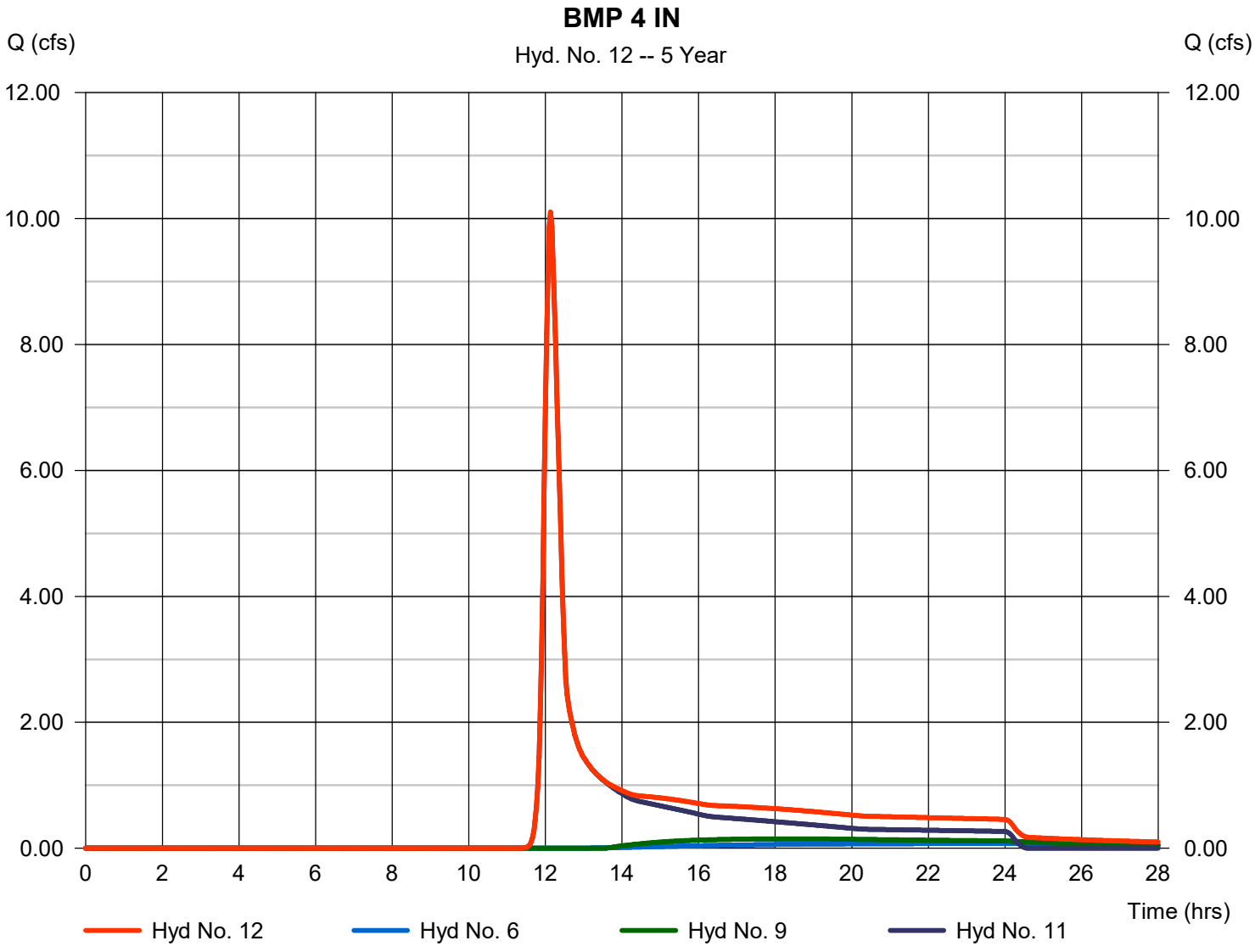
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 12

BMP 4 IN

Hydrograph type	= Combine	Peak discharge	= 10.10 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 51,642 cuft
Inflow hyds.	= 6, 9, 11	Contrib. drain. area	= 9.670 ac



Hydrograph Report

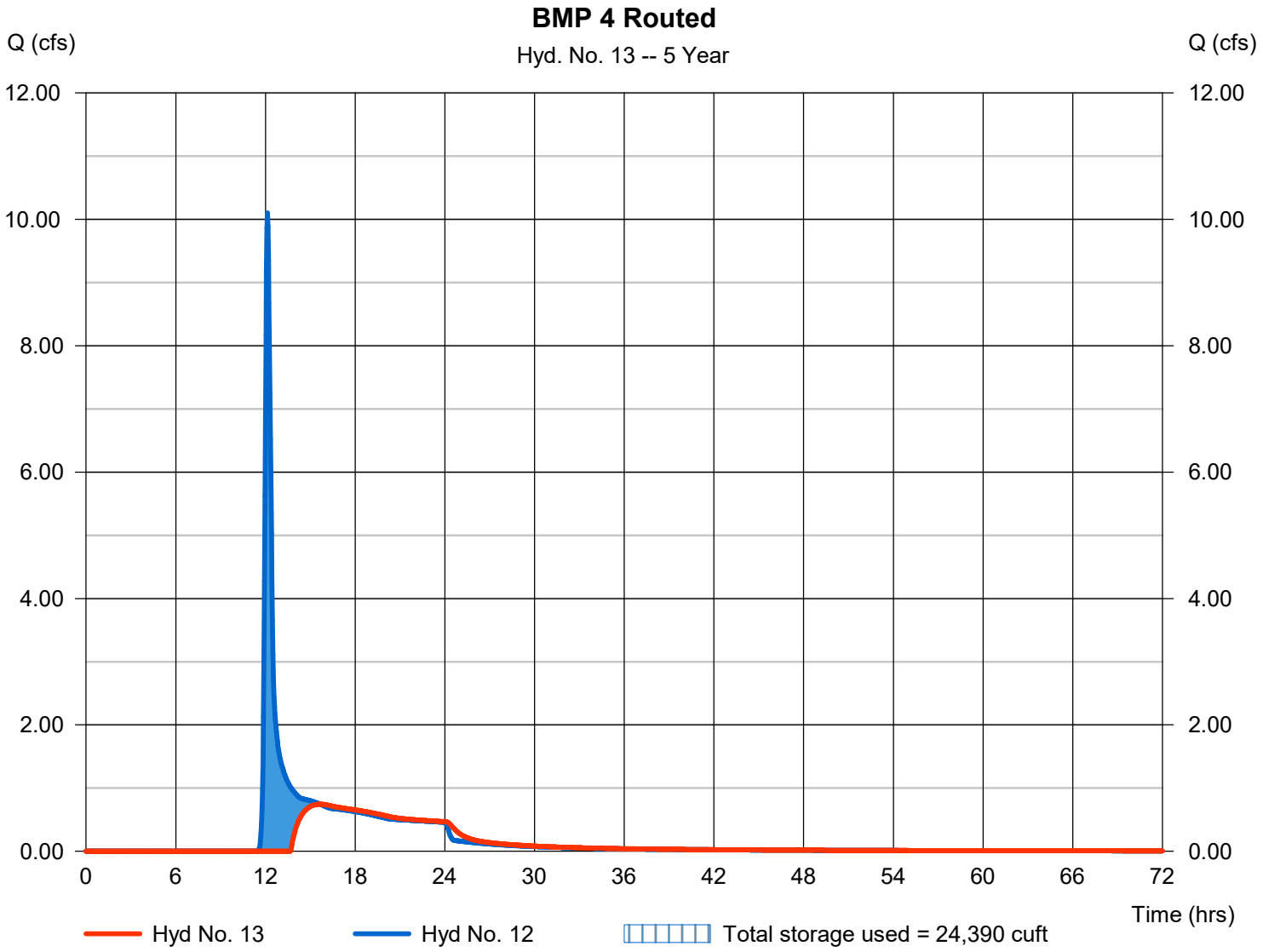
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	0.745 cfs
Storm frequency	=	5 yrs	Time to peak	=	15.67 hrs
Time interval	=	2 min	Hyd. volume	=	29,154 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.07 ft
Reservoir name	=	BMP 4	Max. Storage	=	24,390 cuft

Storage Indication method used.



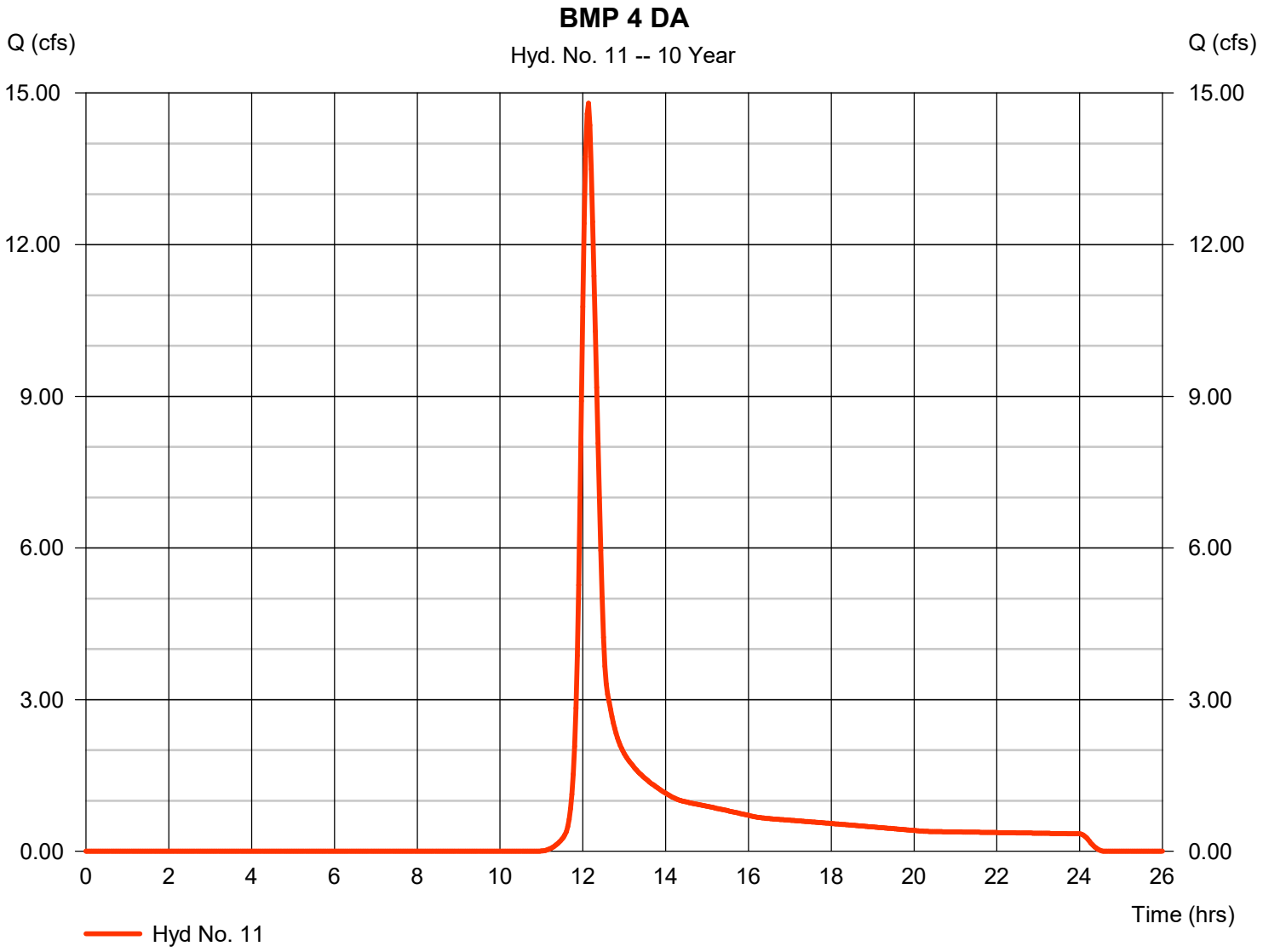
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.80 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	54,377 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	4.80 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

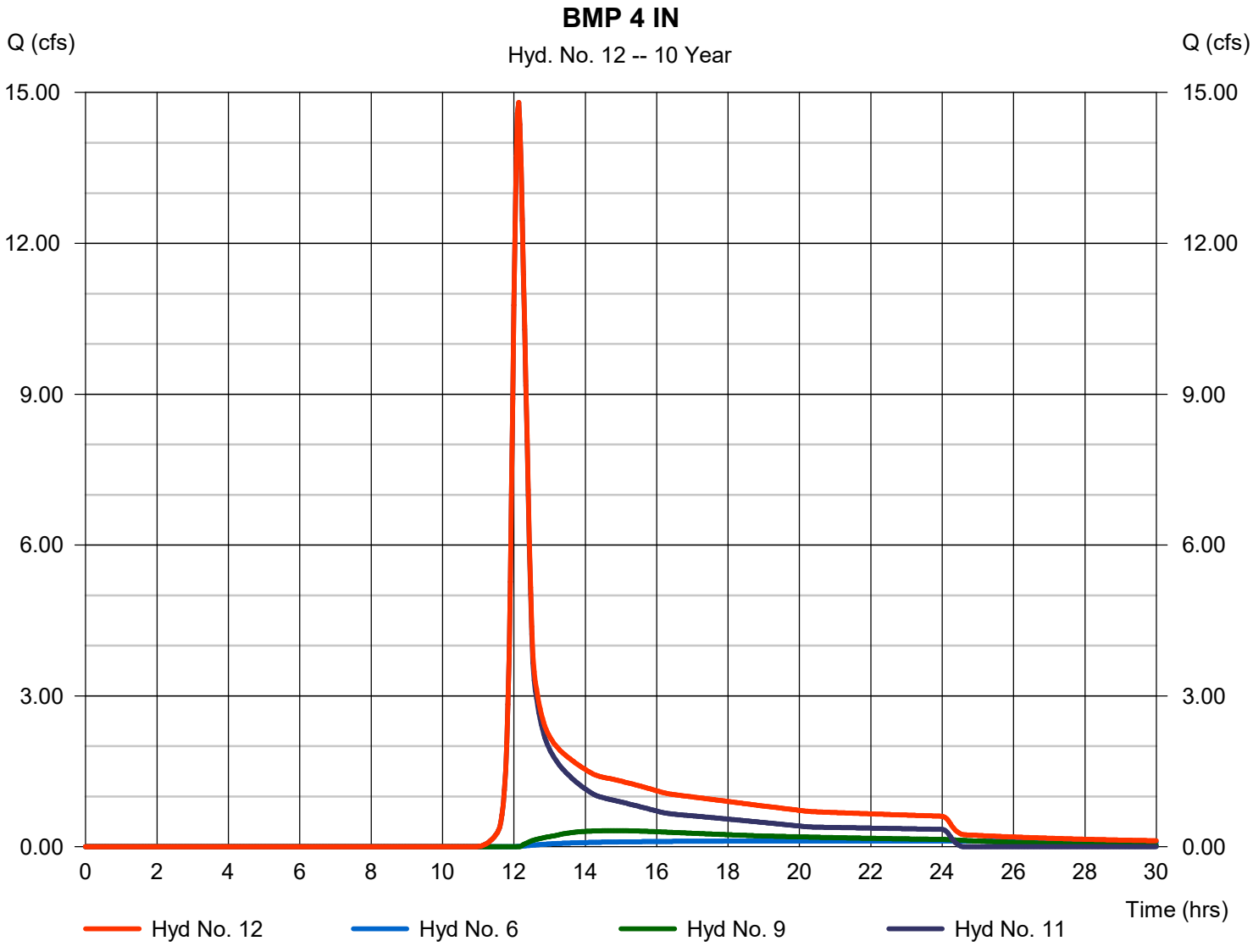


Hydrograph Report

Hyd. No. 12

BMP 4 IN

Hydrograph type	=	Combine	Peak discharge	=	14.80 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	77,602 cuft
Inflow hyds.	=	6, 9, 11	Contrib. drain. area	=	9.670 ac



Hydrograph Report

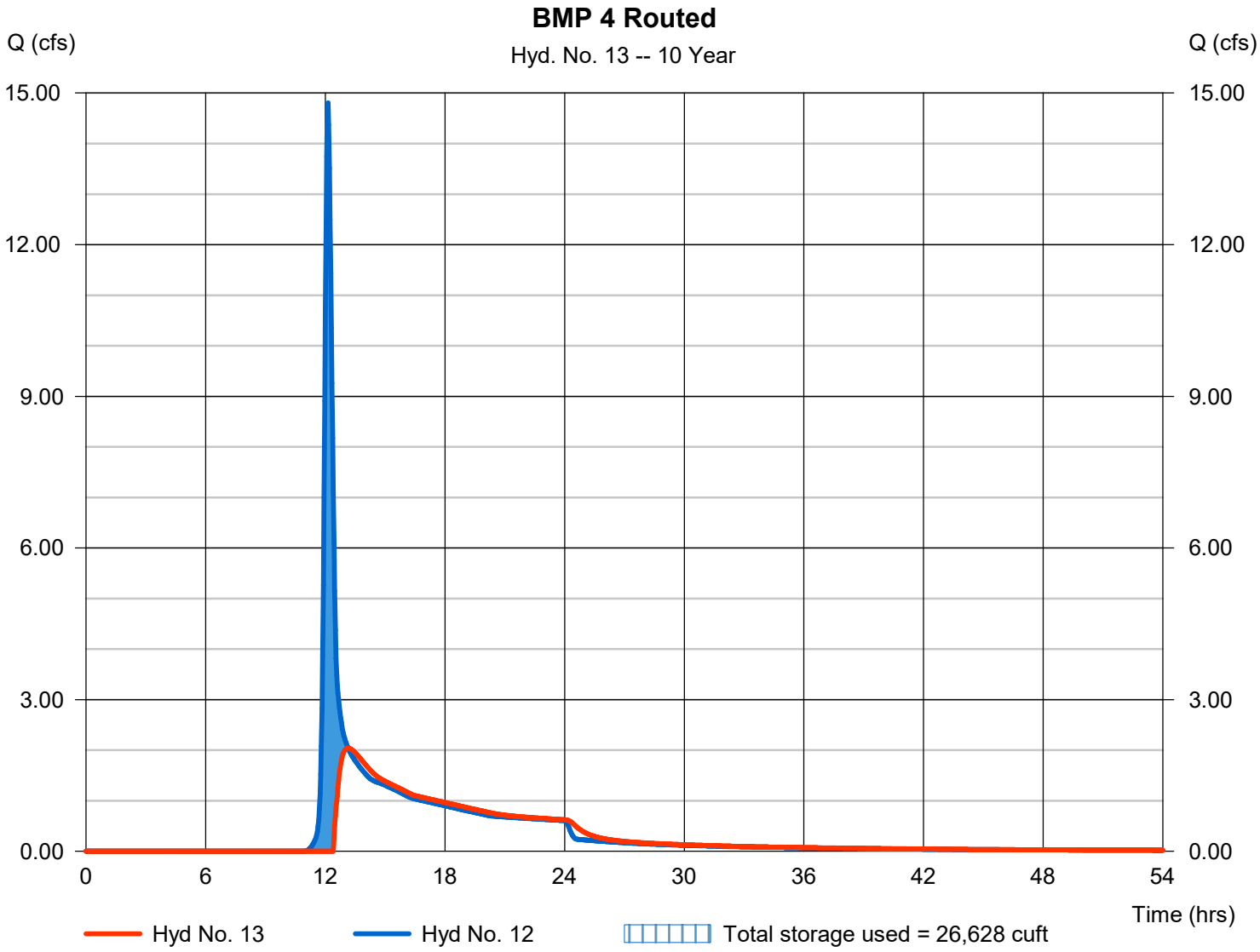
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	2.040 cfs
Storm frequency	=	10 yrs	Time to peak	=	13.13 hrs
Time interval	=	2 min	Hyd. volume	=	55,111 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.15 ft
Reservoir name	=	BMP 4	Max. Storage	=	26,628 cuft

Storage Indication method used.



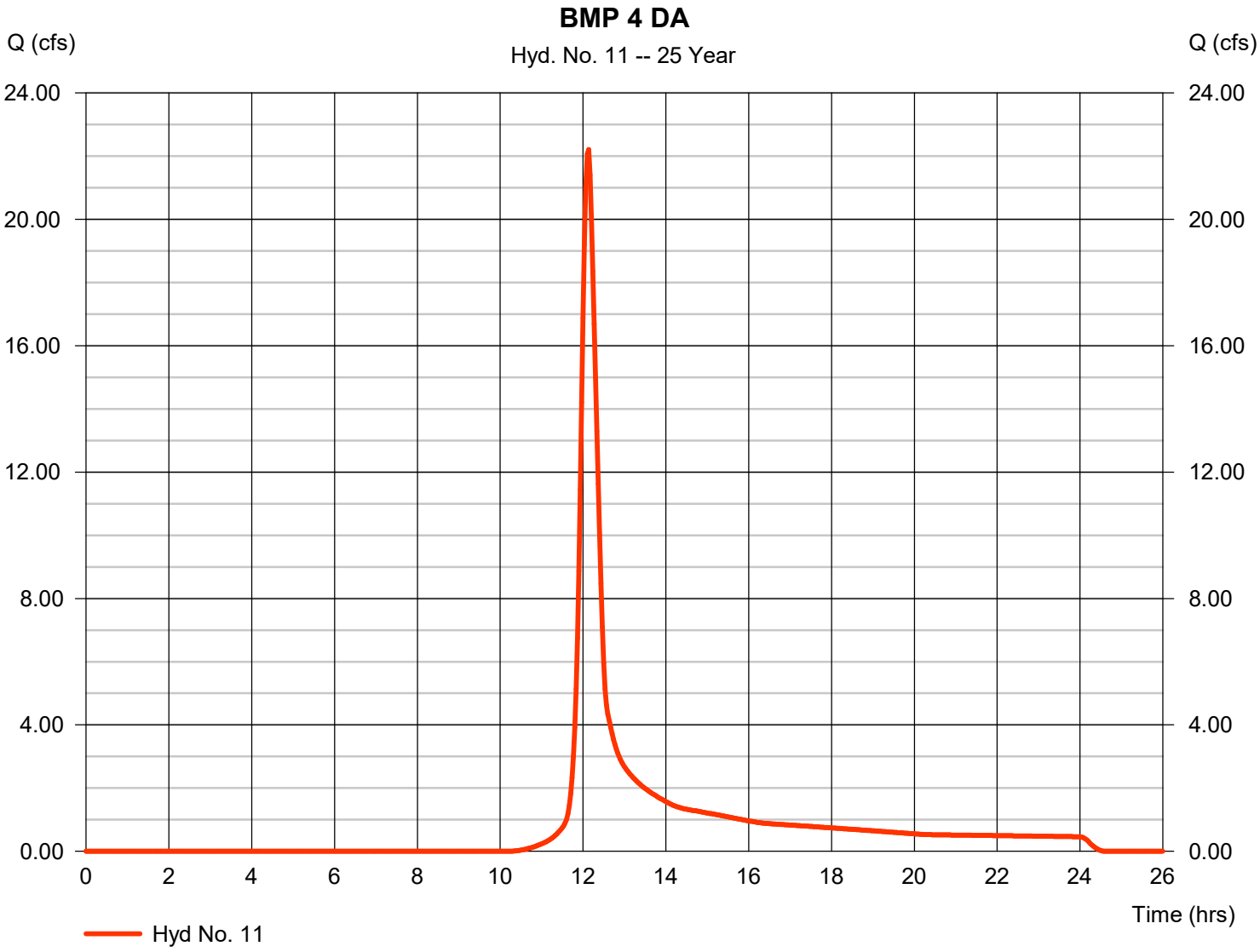
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	22.21 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	79,109 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



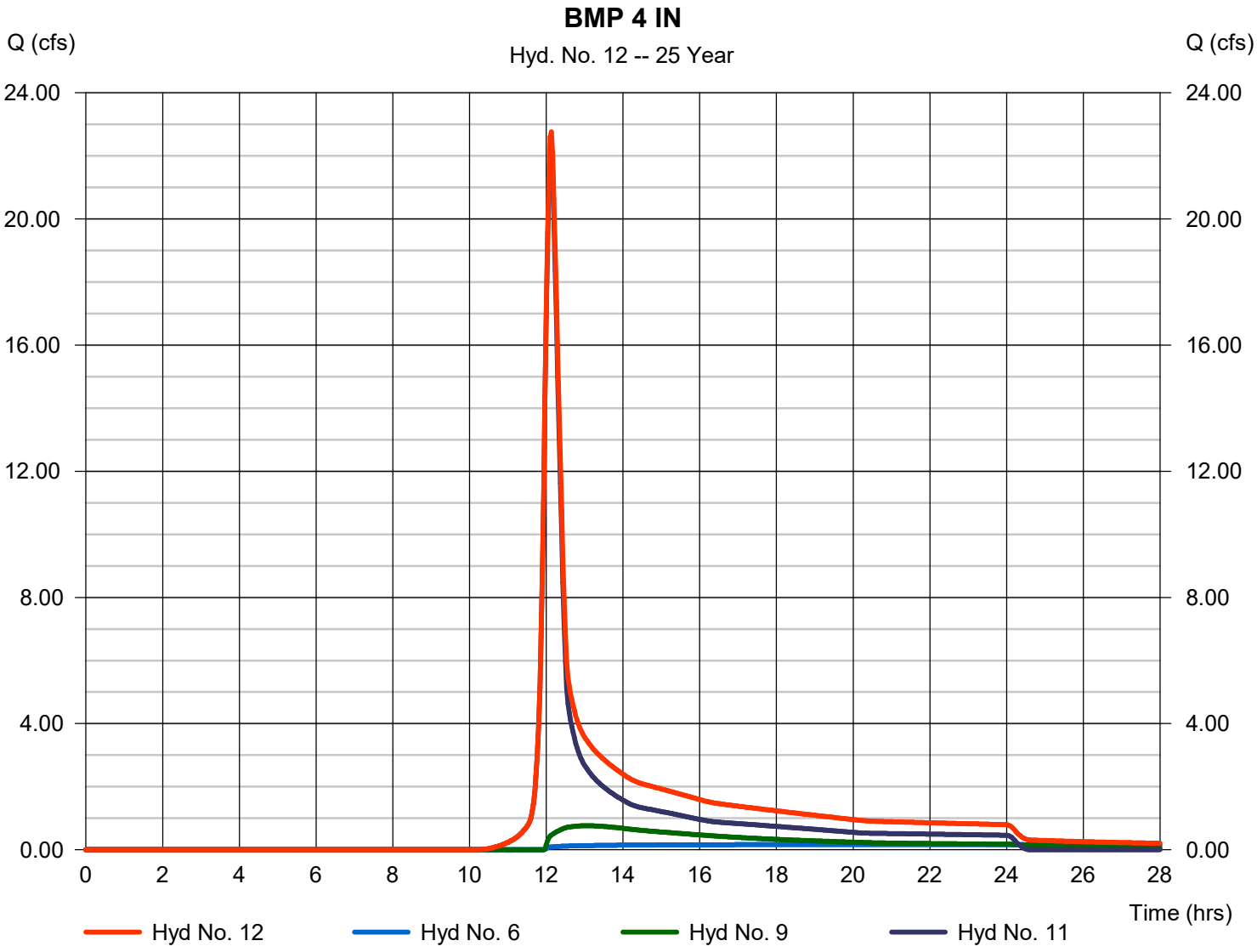
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 12

BMP 4 IN

Hydrograph type	=	Combine	Peak discharge	=	22.76 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	117,372 cuft
Inflow hyds.	=	6, 9, 11	Contrib. drain. area	=	9.670 ac



Hydrograph Report

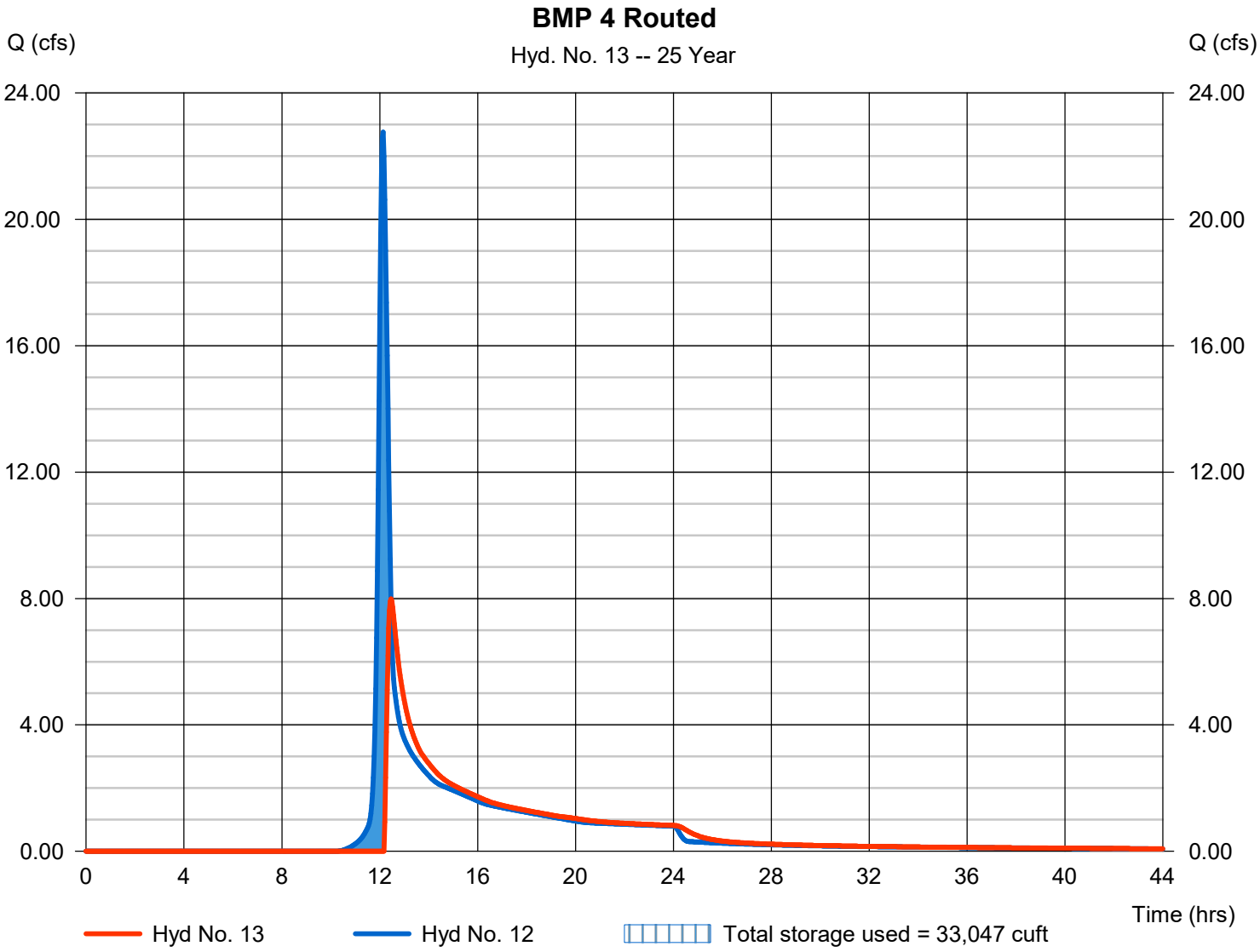
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	7.989 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.47 hrs
Time interval	=	2 min	Hyd. volume	=	94,878 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.37 ft
Reservoir name	=	BMP 4	Max. Storage	=	33,047 cuft

Storage Indication method used.



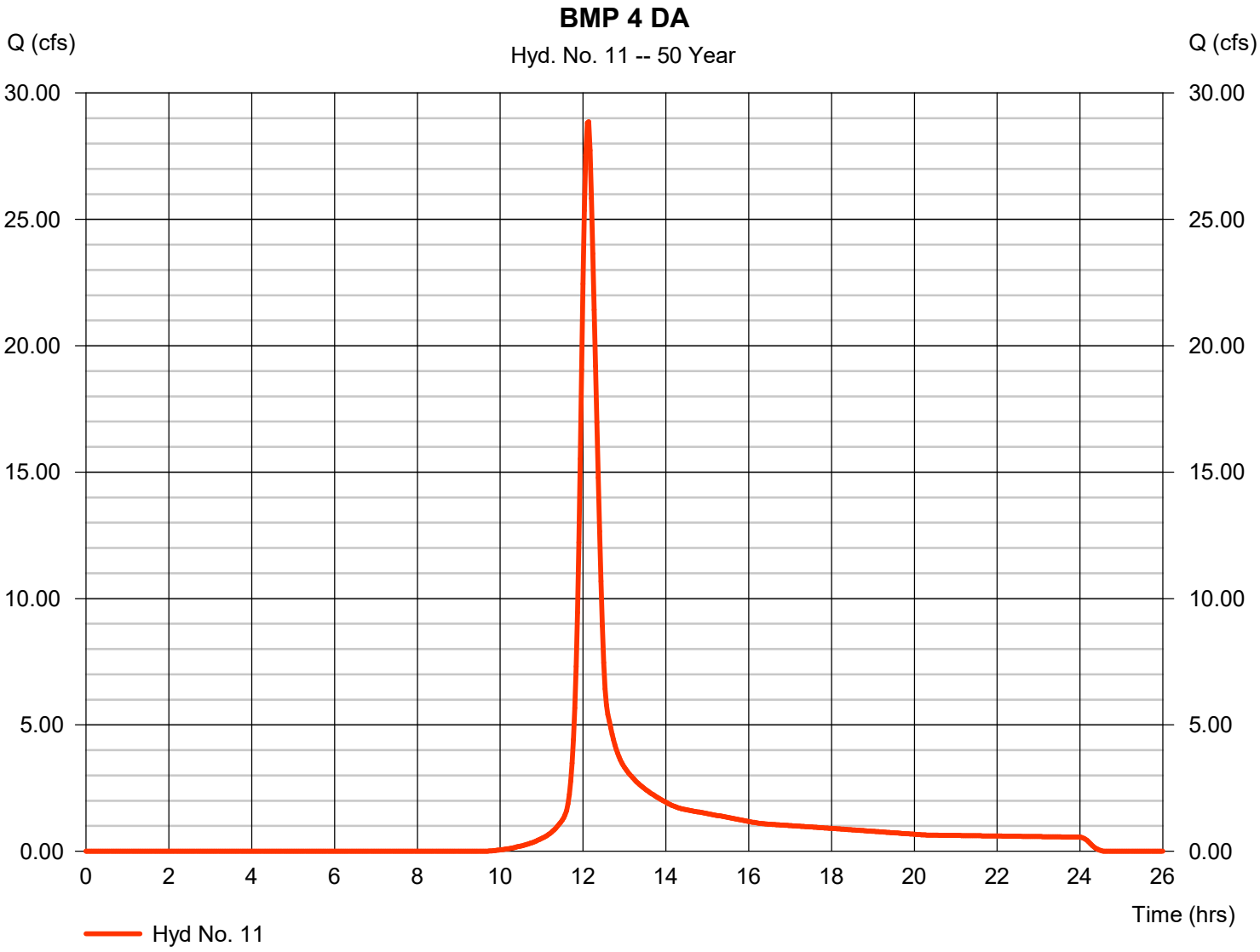
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	28.86 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.13 hrs
Time interval	=	2 min	Hyd. volume	=	101,543 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



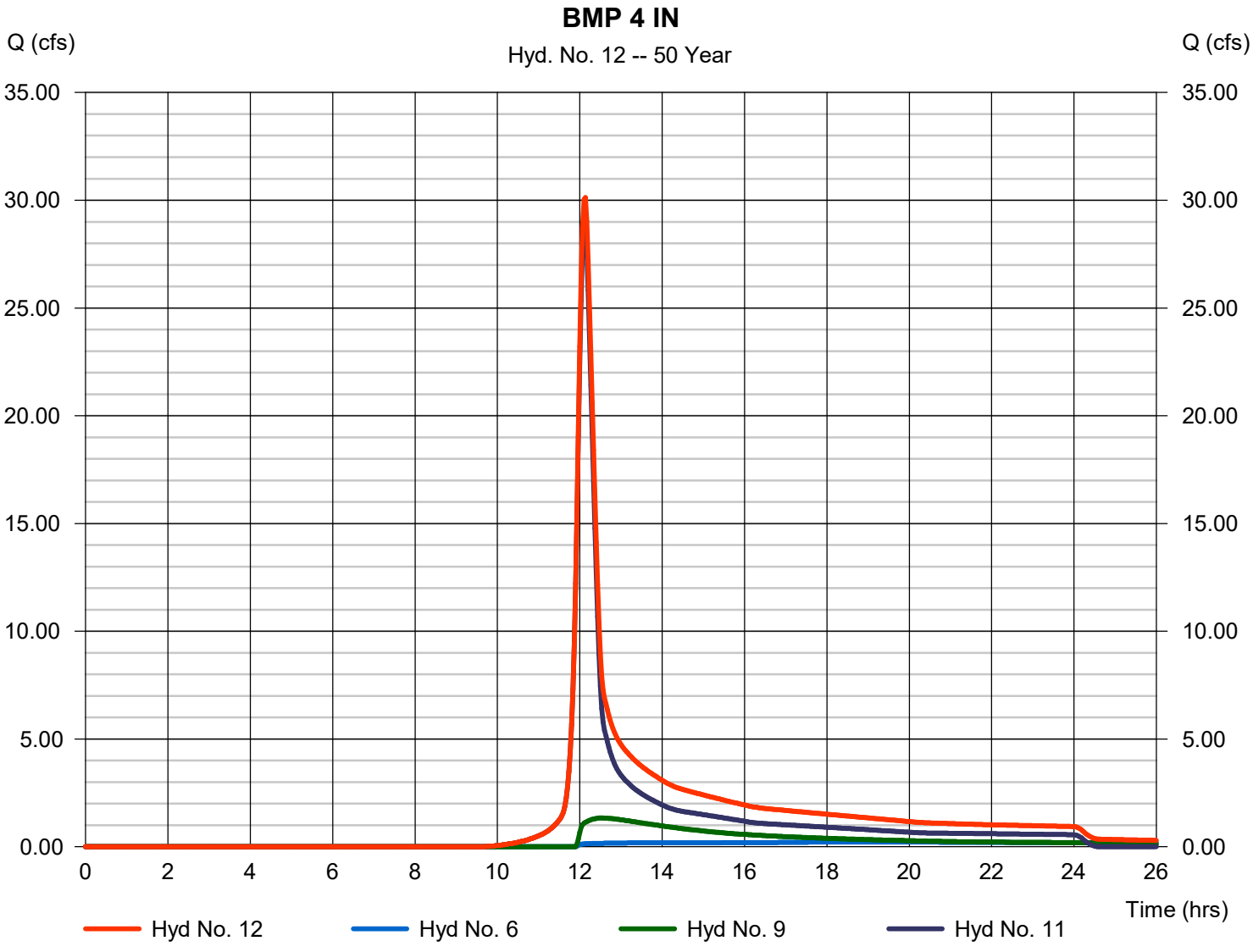
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 12

BMP 4 IN

Hydrograph type	= Combine	Peak discharge	= 30.13 cfs
Storm frequency	= 50 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 152,462 cuft
Inflow hyds.	= 6, 9, 11	Contrib. drain. area	= 9.670 ac



Hydrograph Report

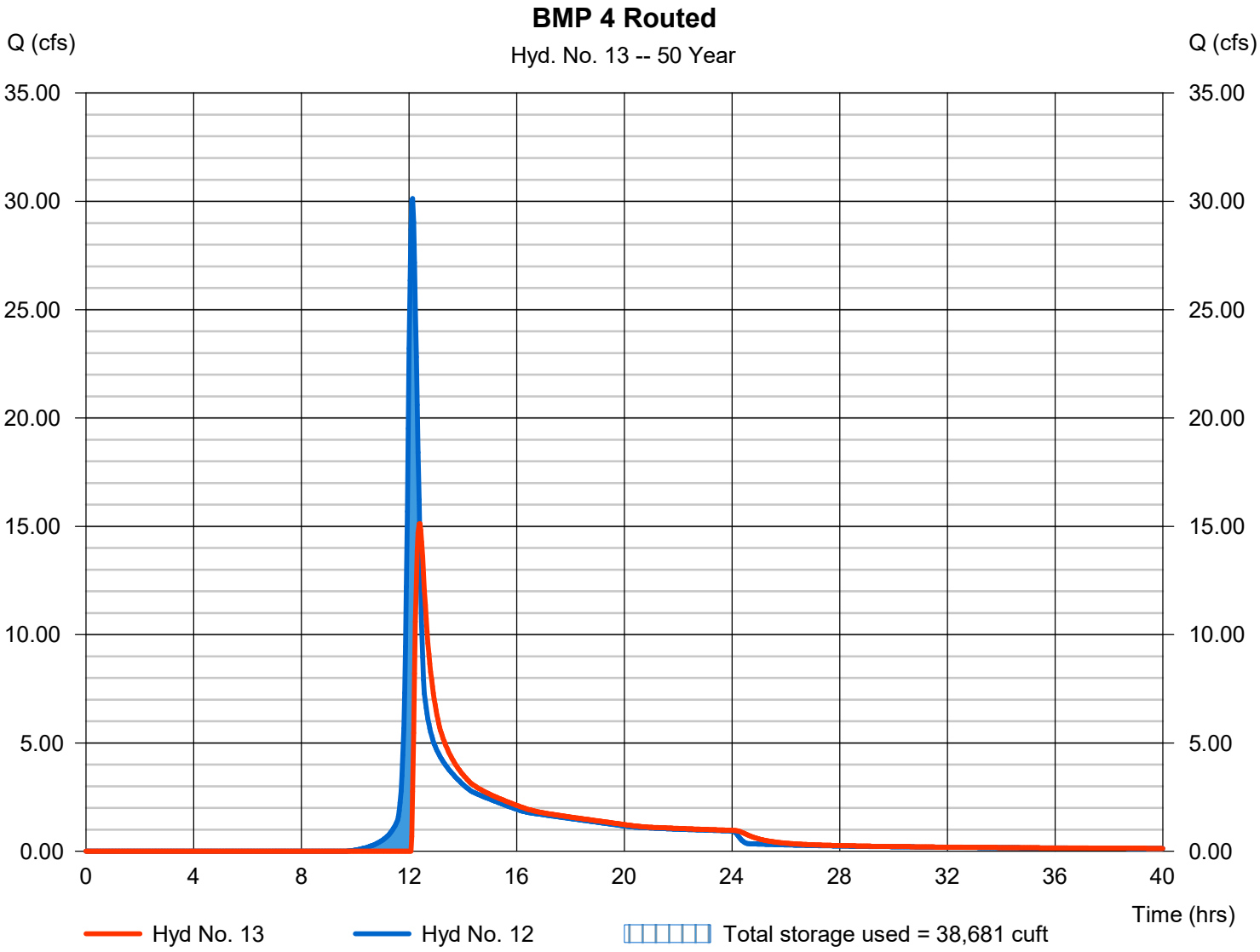
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	15.12 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.40 hrs
Time interval	=	2 min	Hyd. volume	=	129,965 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.57 ft
Reservoir name	=	BMP 4	Max. Storage	=	38,681 cuft

Storage Indication method used.



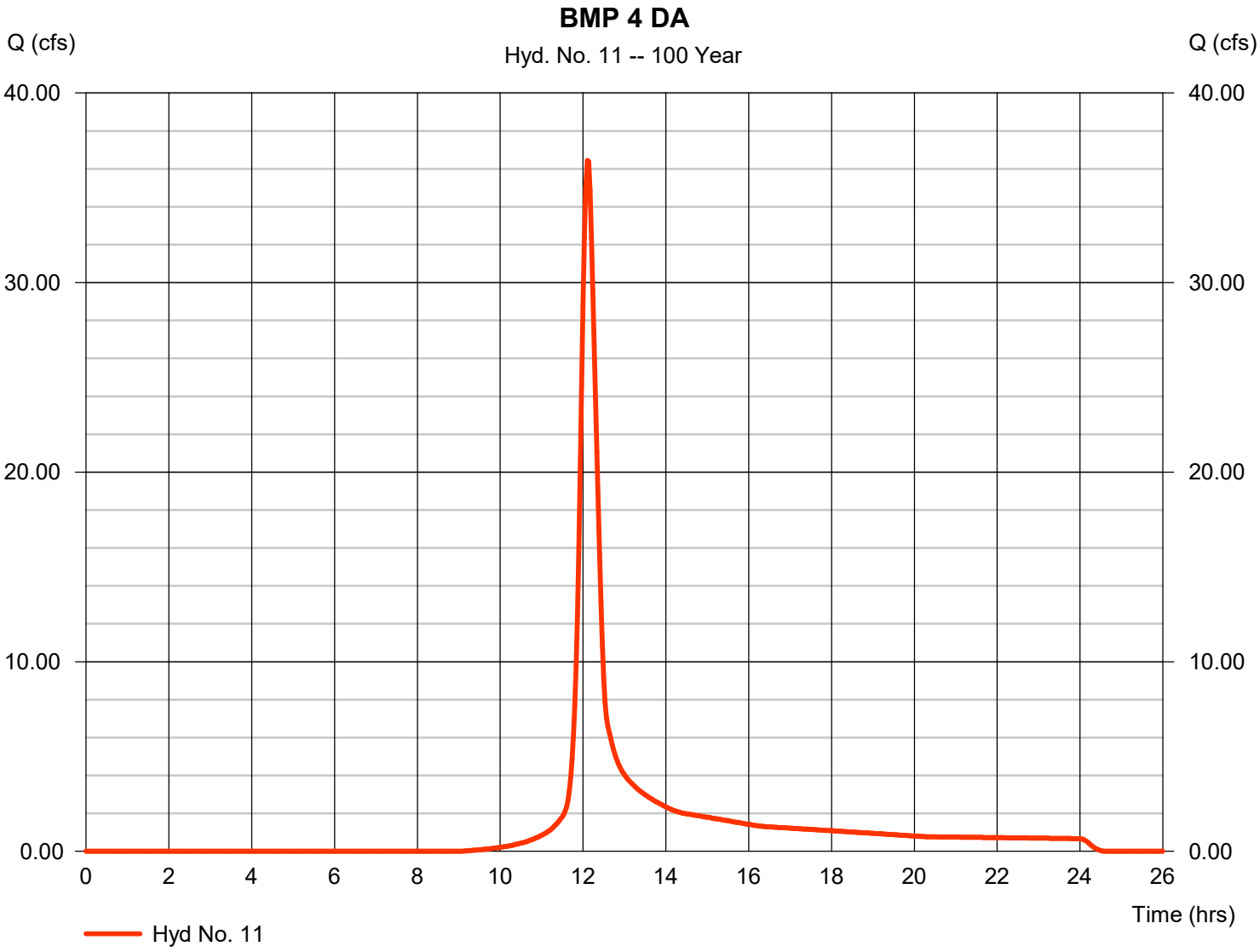
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 11

BMP 4 DA

Hydrograph type	=	SCS Runoff	Peak discharge	=	36.45 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.10 hrs
Time interval	=	2 min	Hyd. volume	=	127,104 cuft
Drainage area	=	9.670 ac	Curve number	=	65
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	22.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



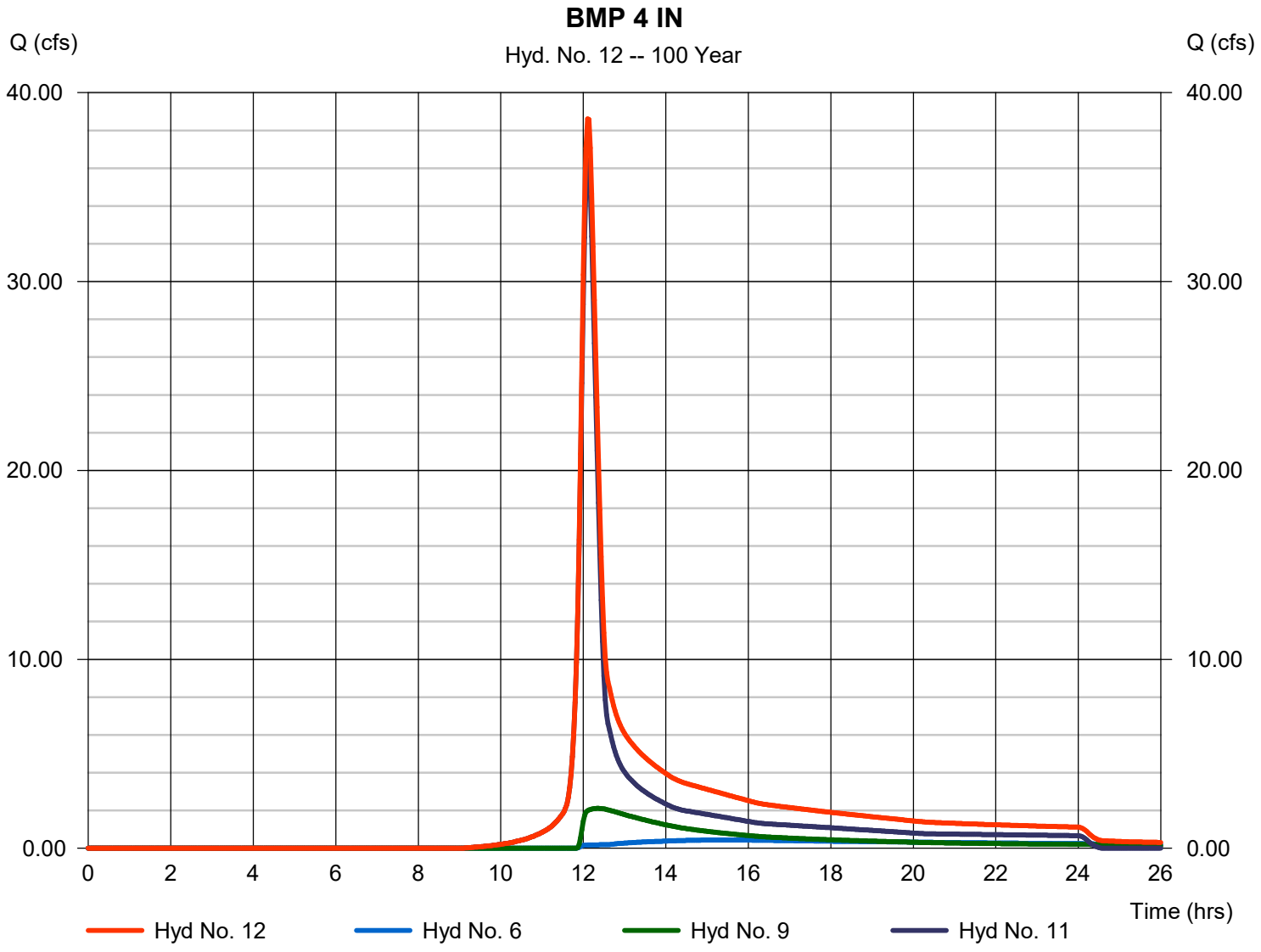
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 12

BMP 4 IN

Hydrograph type	= Combine	Peak discharge	= 38.61 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 191,882 cuft
Inflow hyds.	= 6, 9, 11	Contrib. drain. area	= 9.670 ac



Hydrograph Report

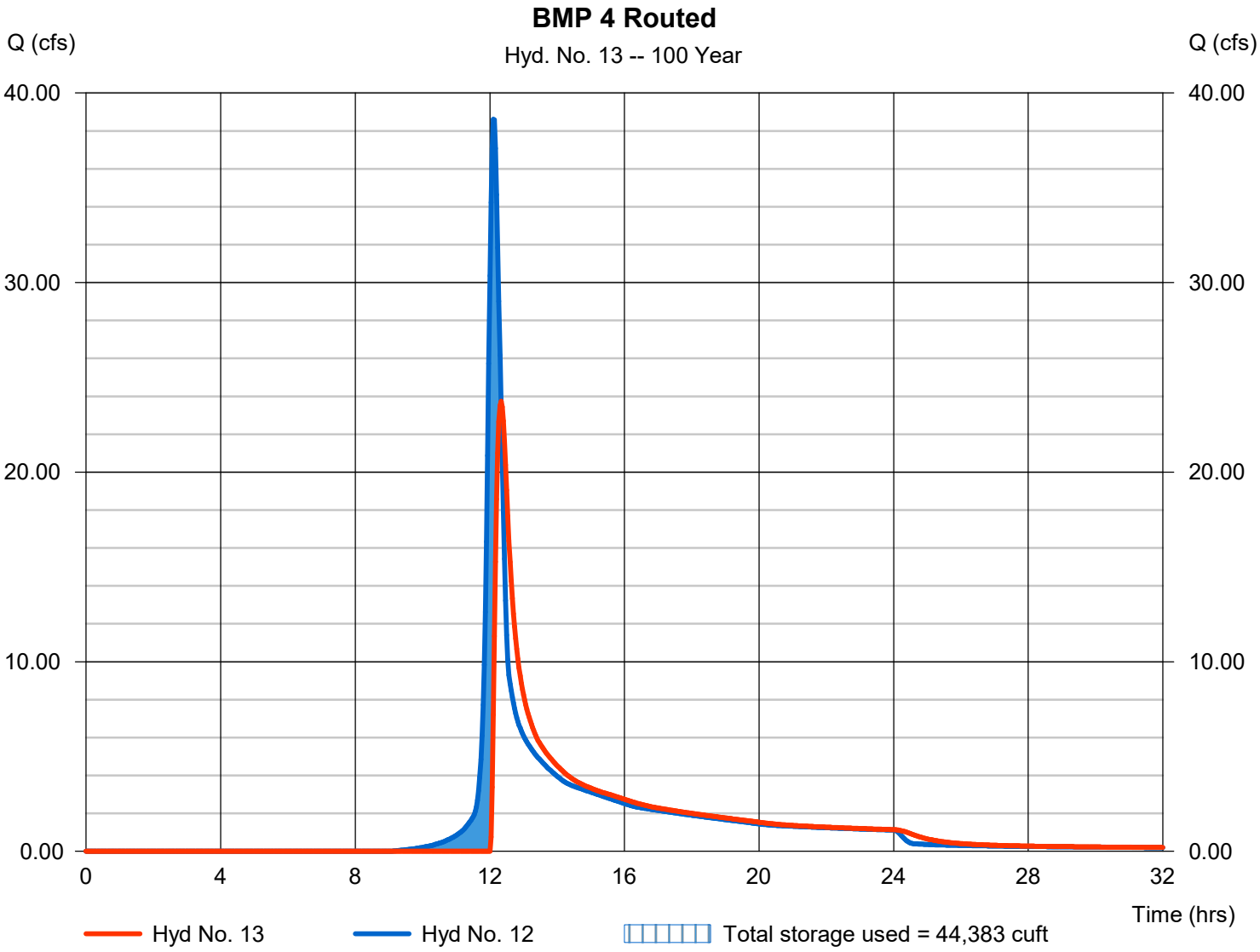
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 13

BMP 4 Routed

Hydrograph type	=	Reservoir	Peak discharge	=	23.74 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.33 hrs
Time interval	=	2 min	Hyd. volume	=	169,384 cuft
Inflow hyd. No.	=	12 - BMP 4 IN	Max. Elevation	=	311.77 ft
Reservoir name	=	BMP 4	Max. Storage	=	44,383 cuft

Storage Indication method used.



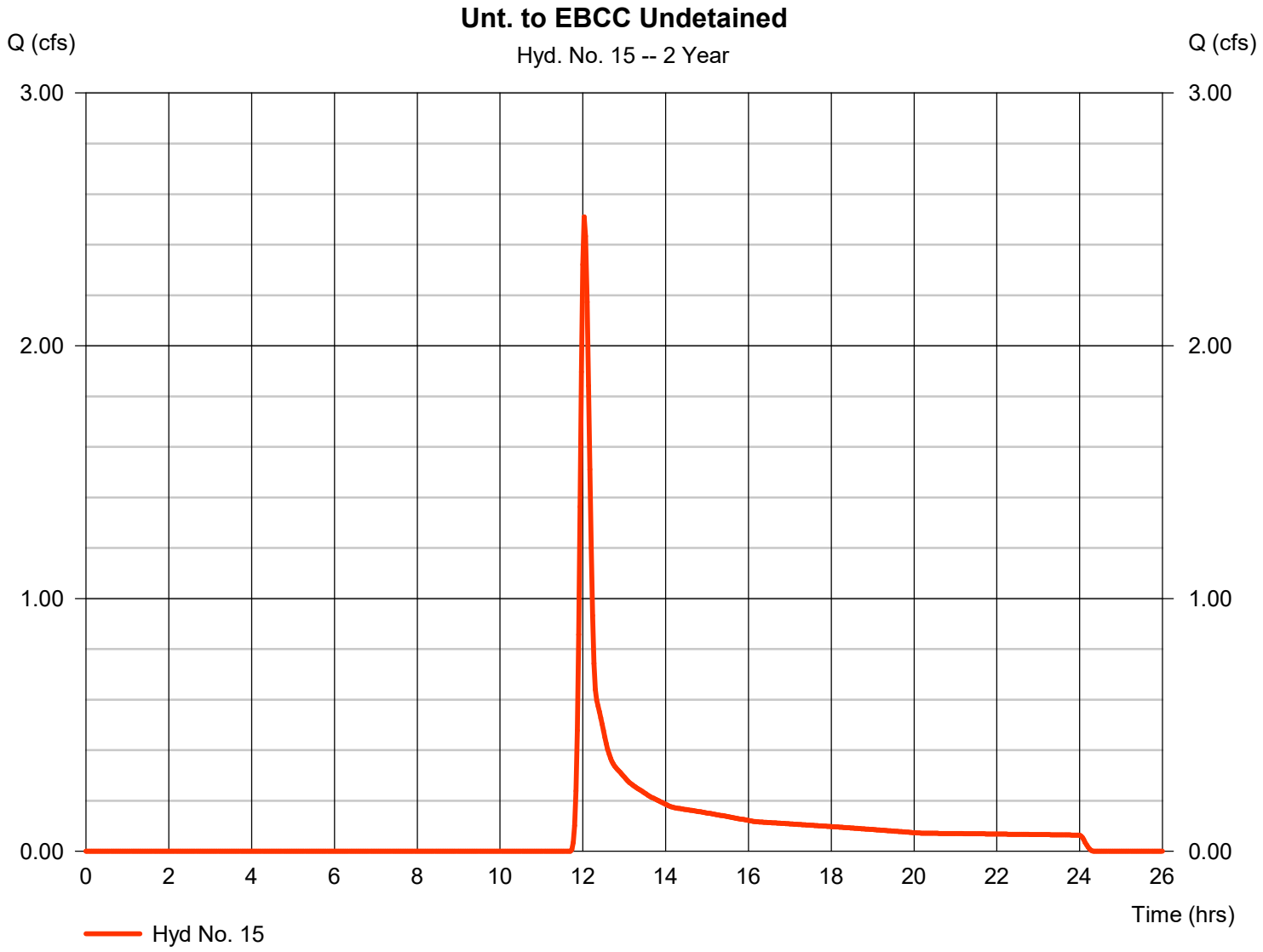
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.510 cfs
Storm frequency	=	2 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	7,892 cuft
Drainage area	=	3.590 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.00 min
Total precip.	=	3.26 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



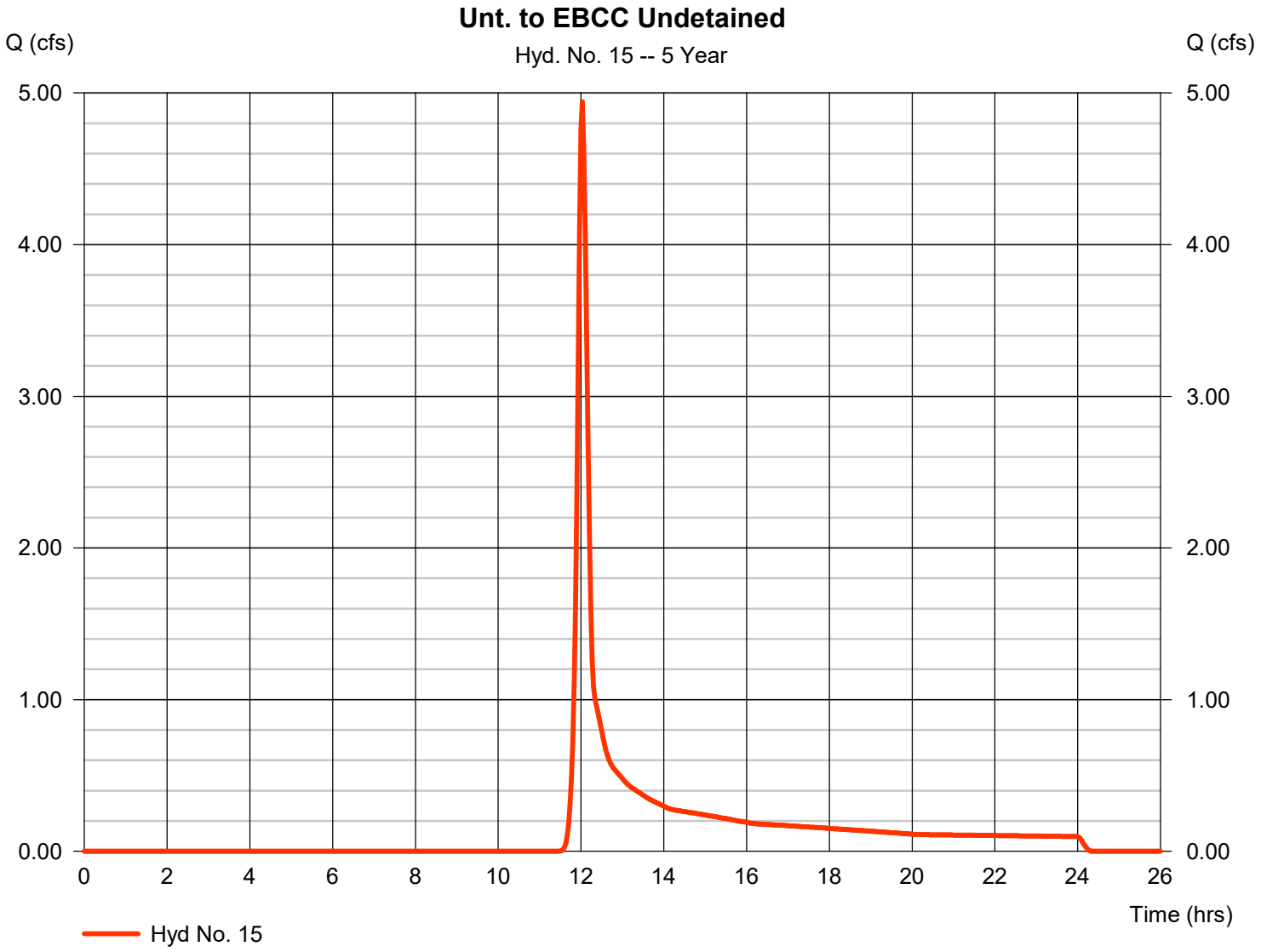
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.941 cfs
Storm frequency	=	5 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	13,831 cuft
Drainage area	=	3.590 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.00 min
Total precip.	=	4.10 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



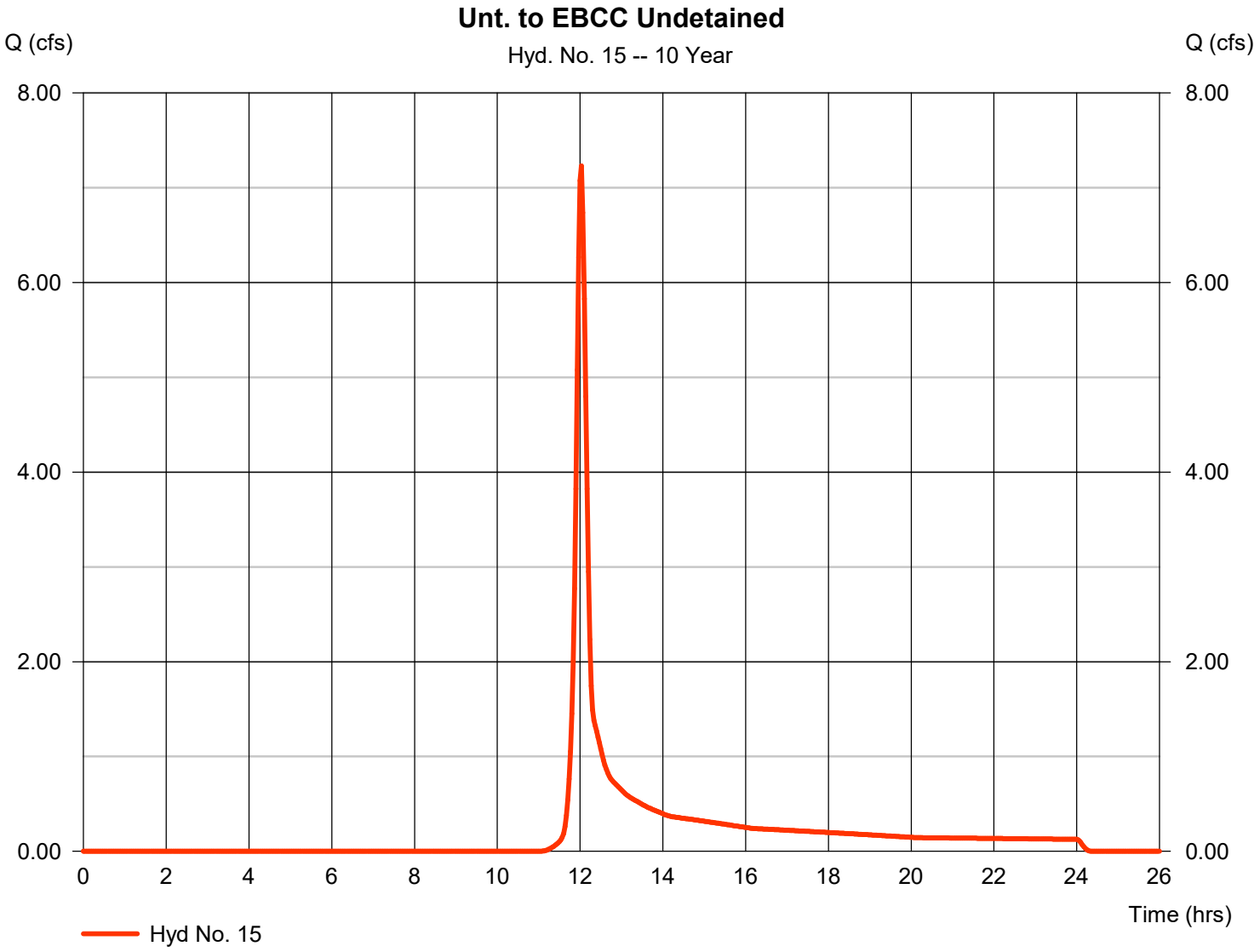
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	= SCS Runoff	Peak discharge	= 7.232 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 19,516 cuft
Drainage area	= 3.590 ac	Curve number	= 64
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 12.00 min
Total precip.	= 4.80 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



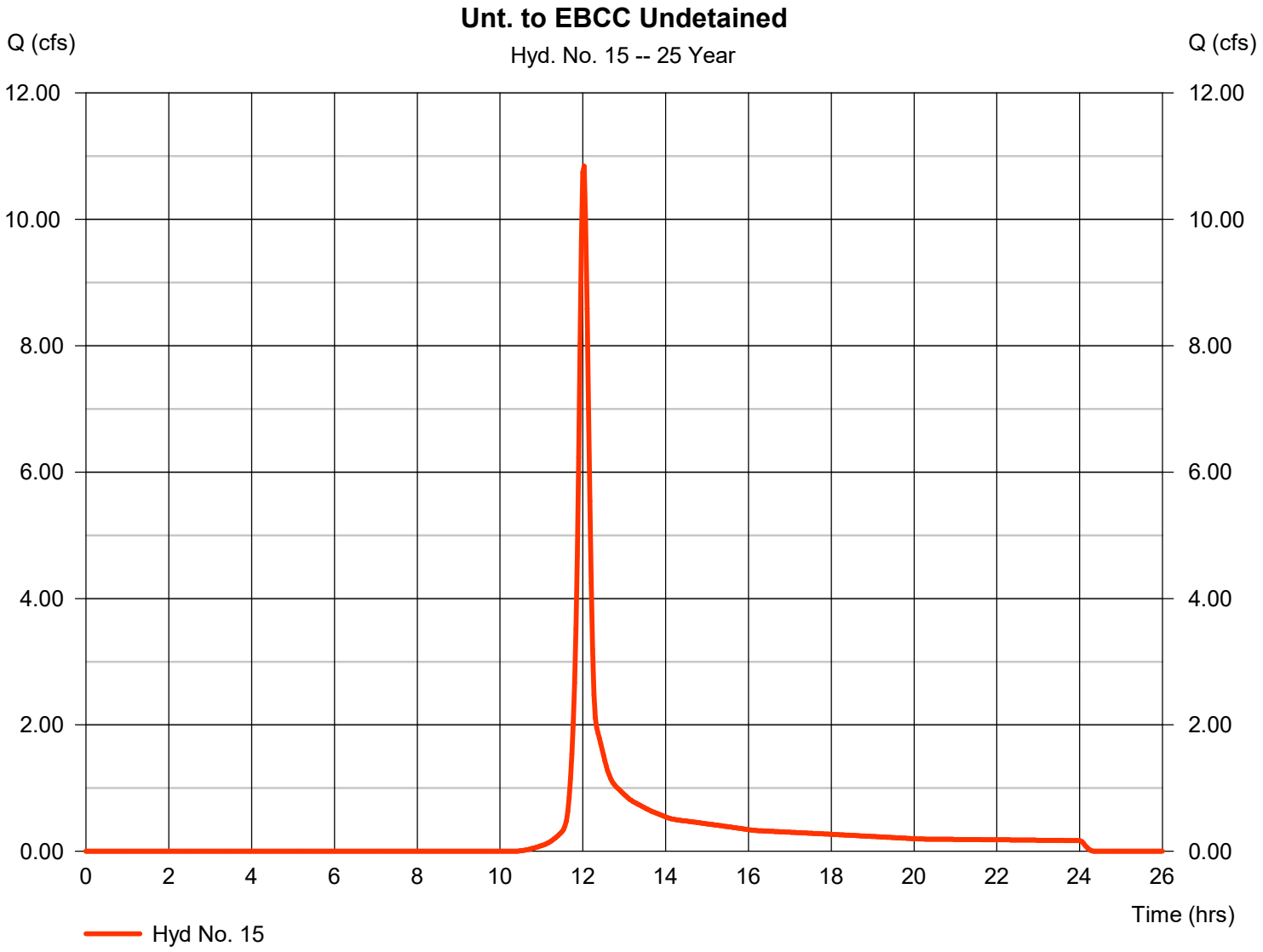
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.84 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	28,610 cuft
Drainage area	=	3.590 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.00 min
Total precip.	=	5.81 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



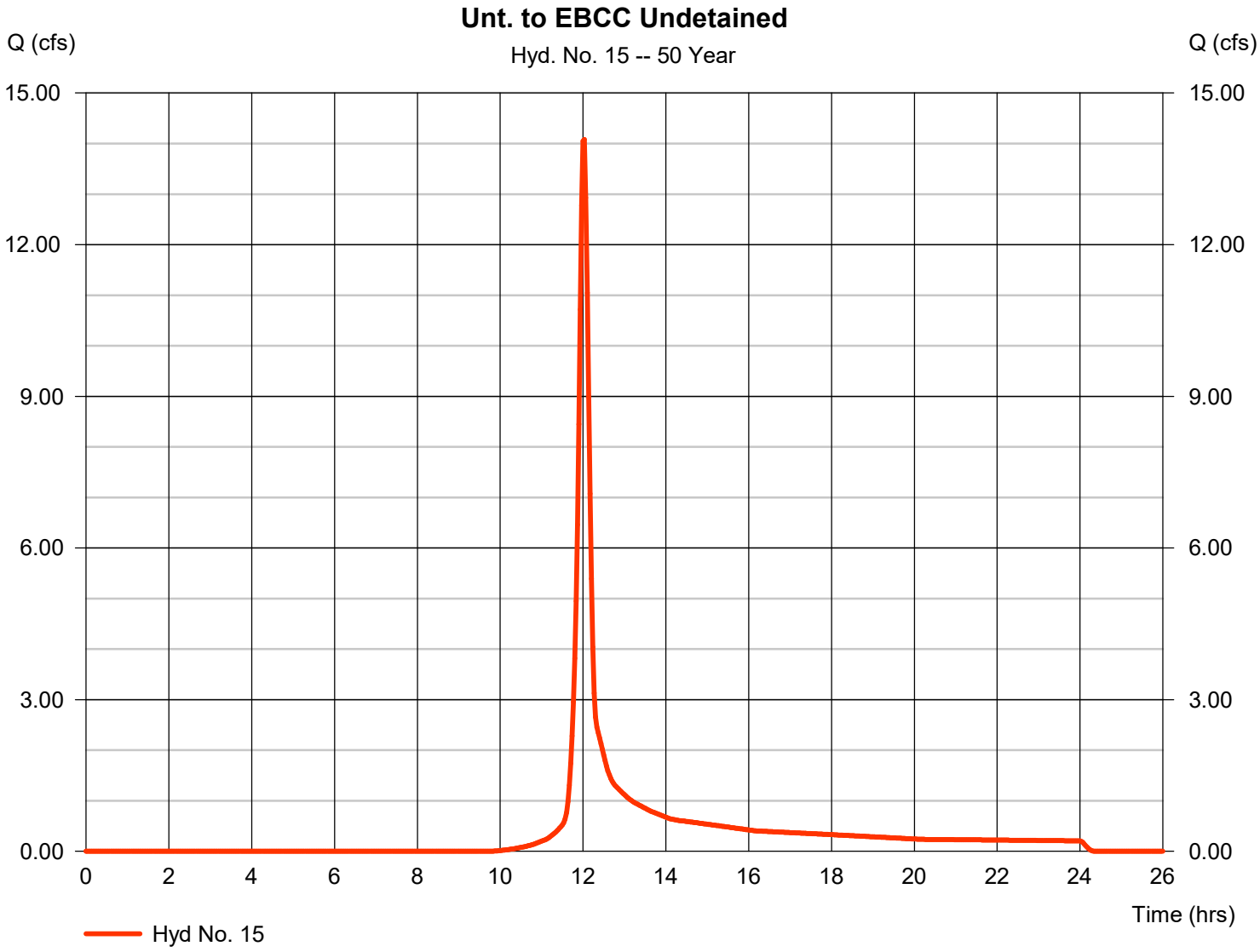
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	14.08 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	36,892 cuft
Drainage area	=	3.590 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.00 min
Total precip.	=	6.66 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

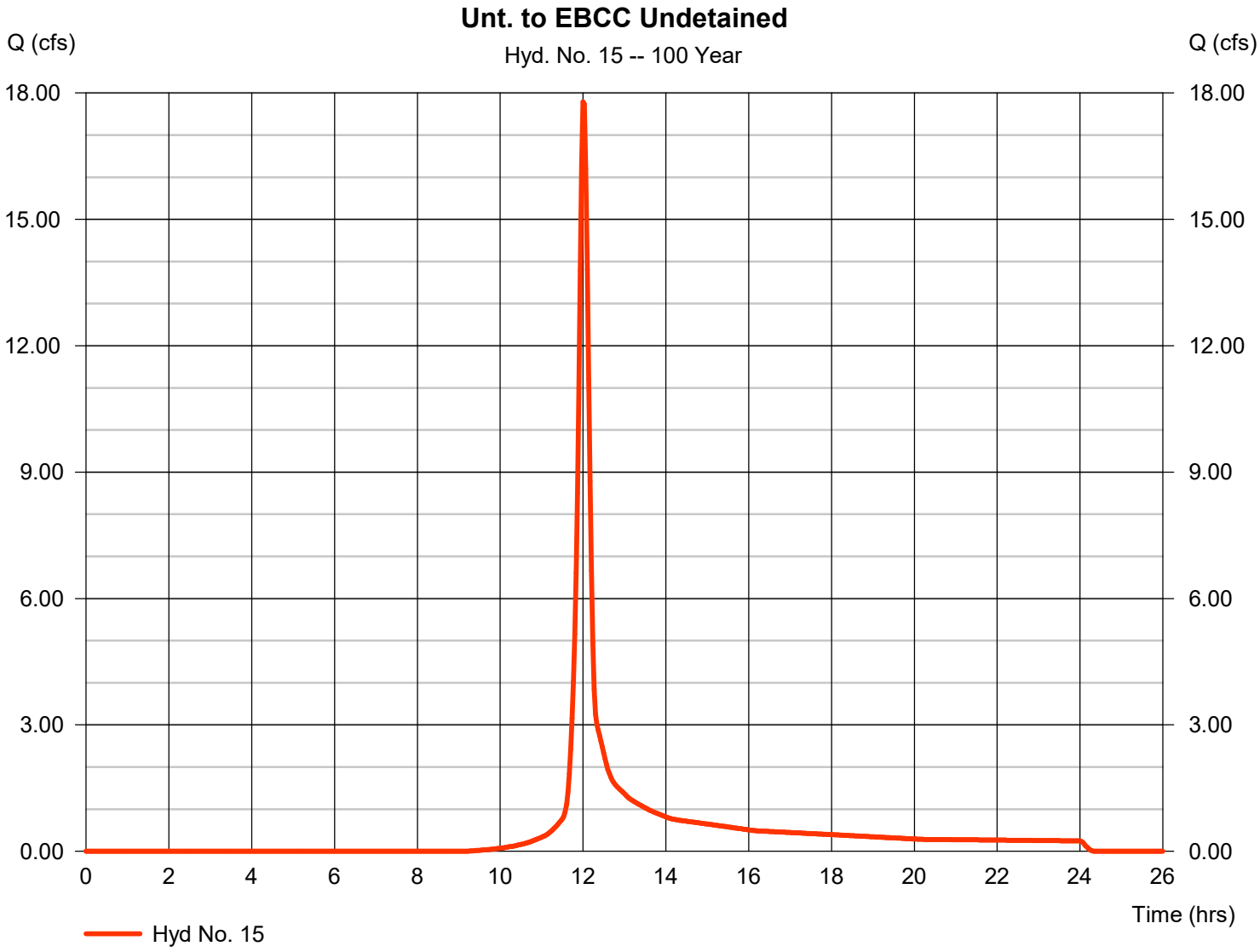


Hydrograph Report

Hyd. No. 15

Unt. to EBCC Undetained

Hydrograph type	=	SCS Runoff	Peak discharge	=	17.79 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.00 hrs
Time interval	=	2 min	Hyd. volume	=	46,354 cuft
Drainage area	=	3.590 ac	Curve number	=	64
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	12.00 min
Total precip.	=	7.58 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

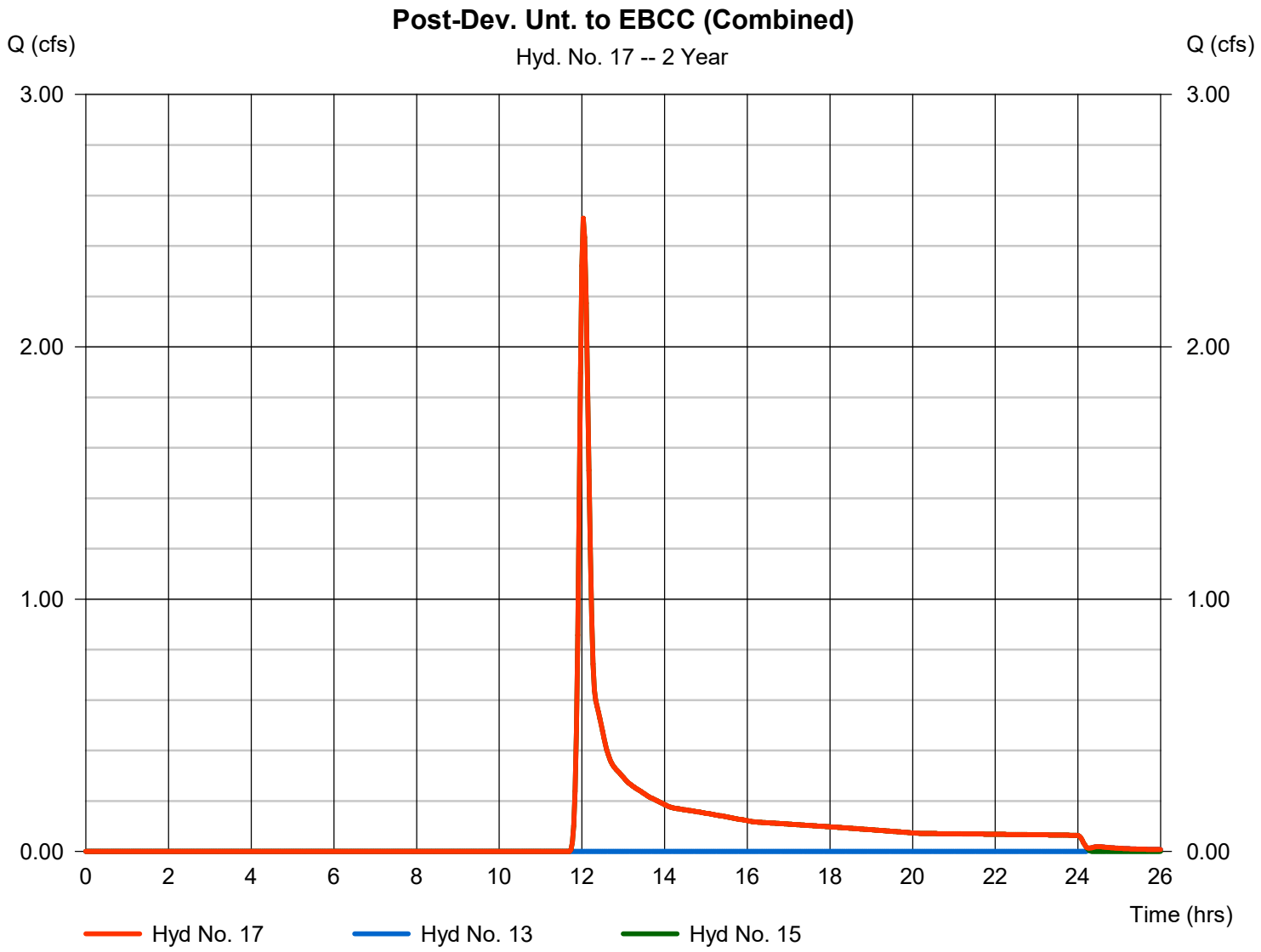


Hydrograph Report

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	= Combine	Peak discharge	= 2.510 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 8,681 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 3.590 ac



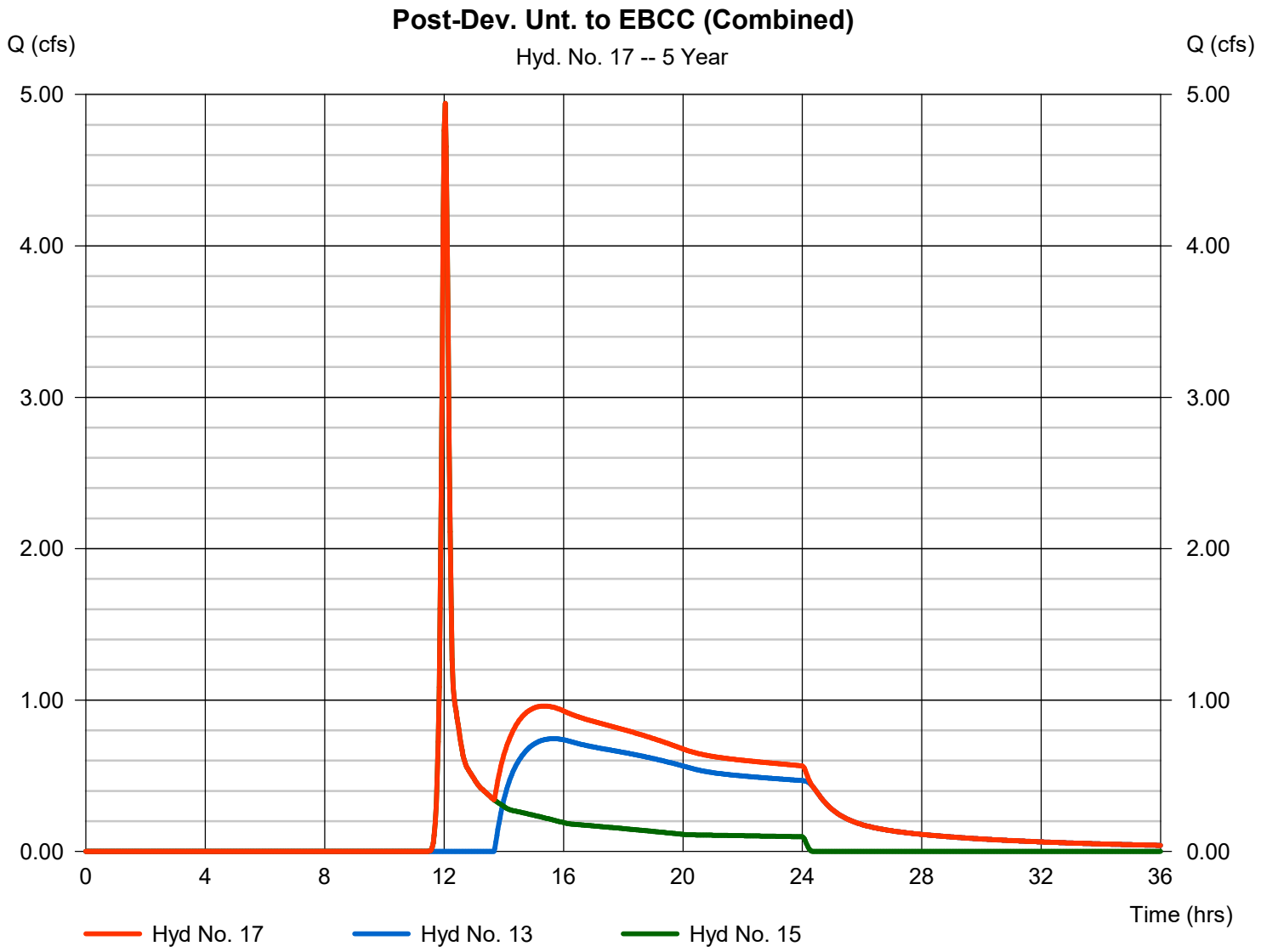
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Monday, 09 / 18 / 2023

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	= Combine	Peak discharge	= 4.941 cfs
Storm frequency	= 5 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 42,984 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 3.590 ac

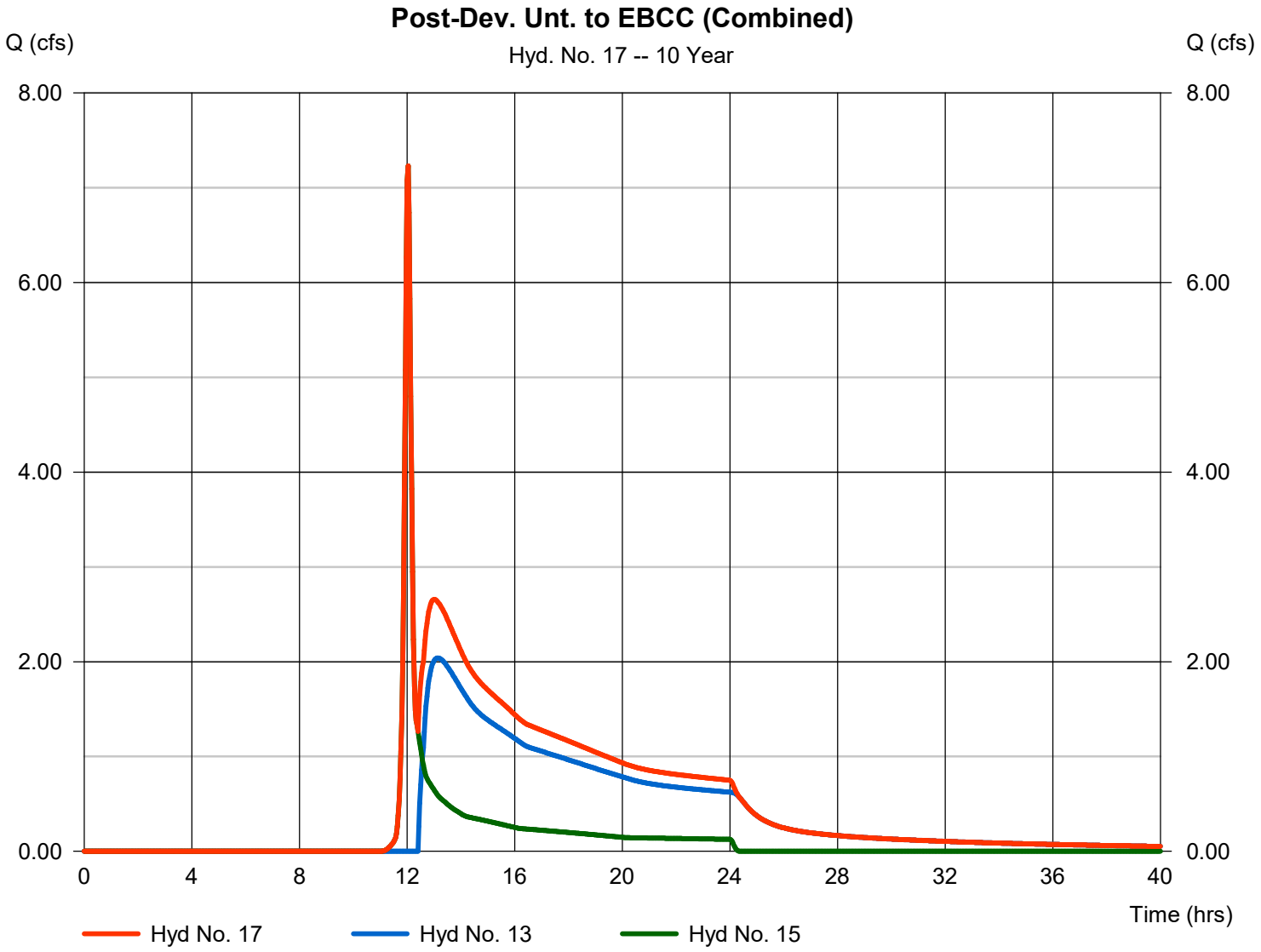


Hydrograph Report

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	= Combine	Peak discharge	= 7.232 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.03 hrs
Time interval	= 2 min	Hyd. volume	= 74,628 cuft
Inflow hyds.	= 13, 15	Contrib. drain. area	= 3.590 ac

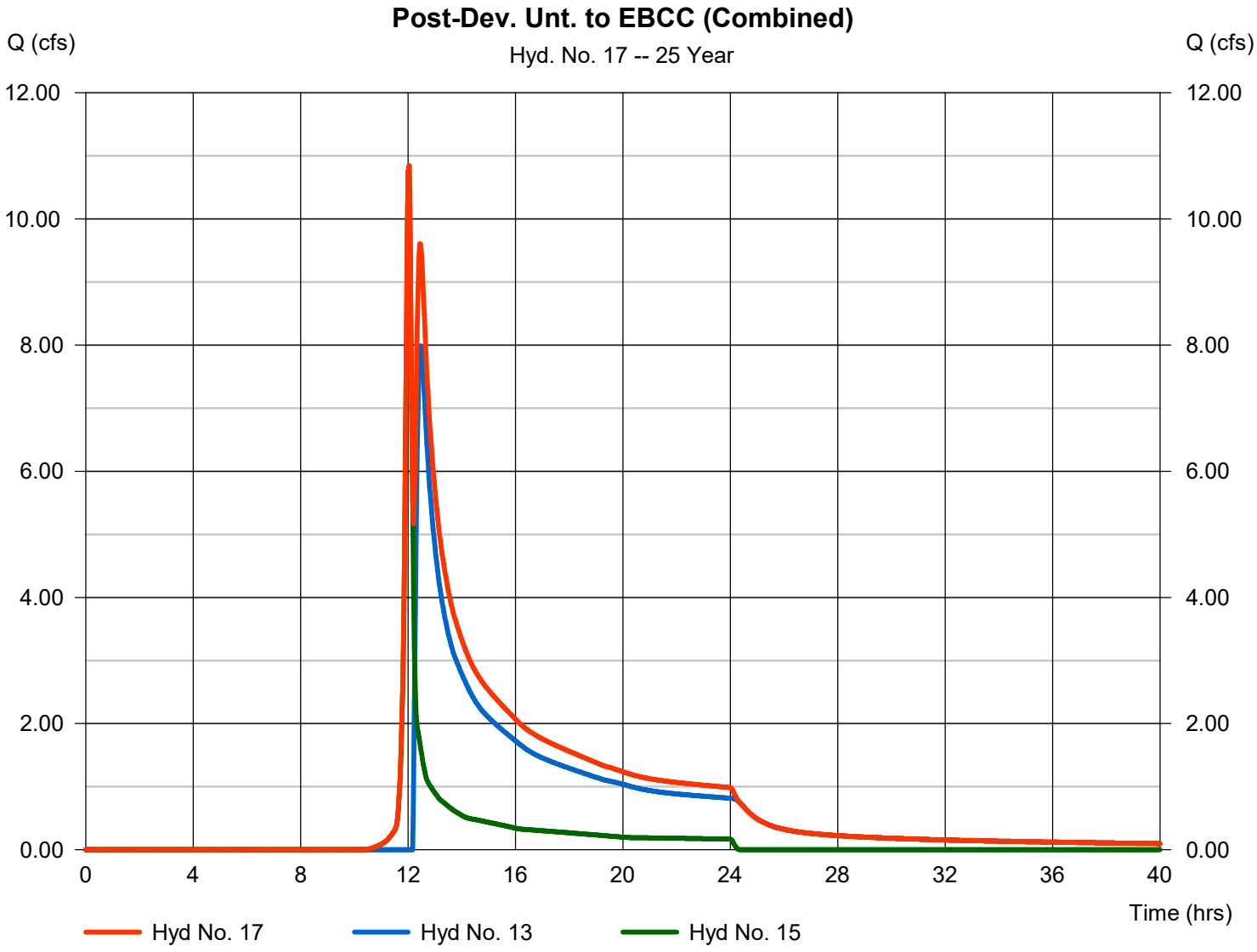


Hydrograph Report

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	=	Combine	Peak discharge	=	10.84 cfs
Storm frequency	=	25 yrs	Time to peak	=	12.03 hrs
Time interval	=	2 min	Hyd. volume	=	123,489 cuft
Inflow hyds.	=	13, 15	Contrib. drain. area	=	3.590 ac

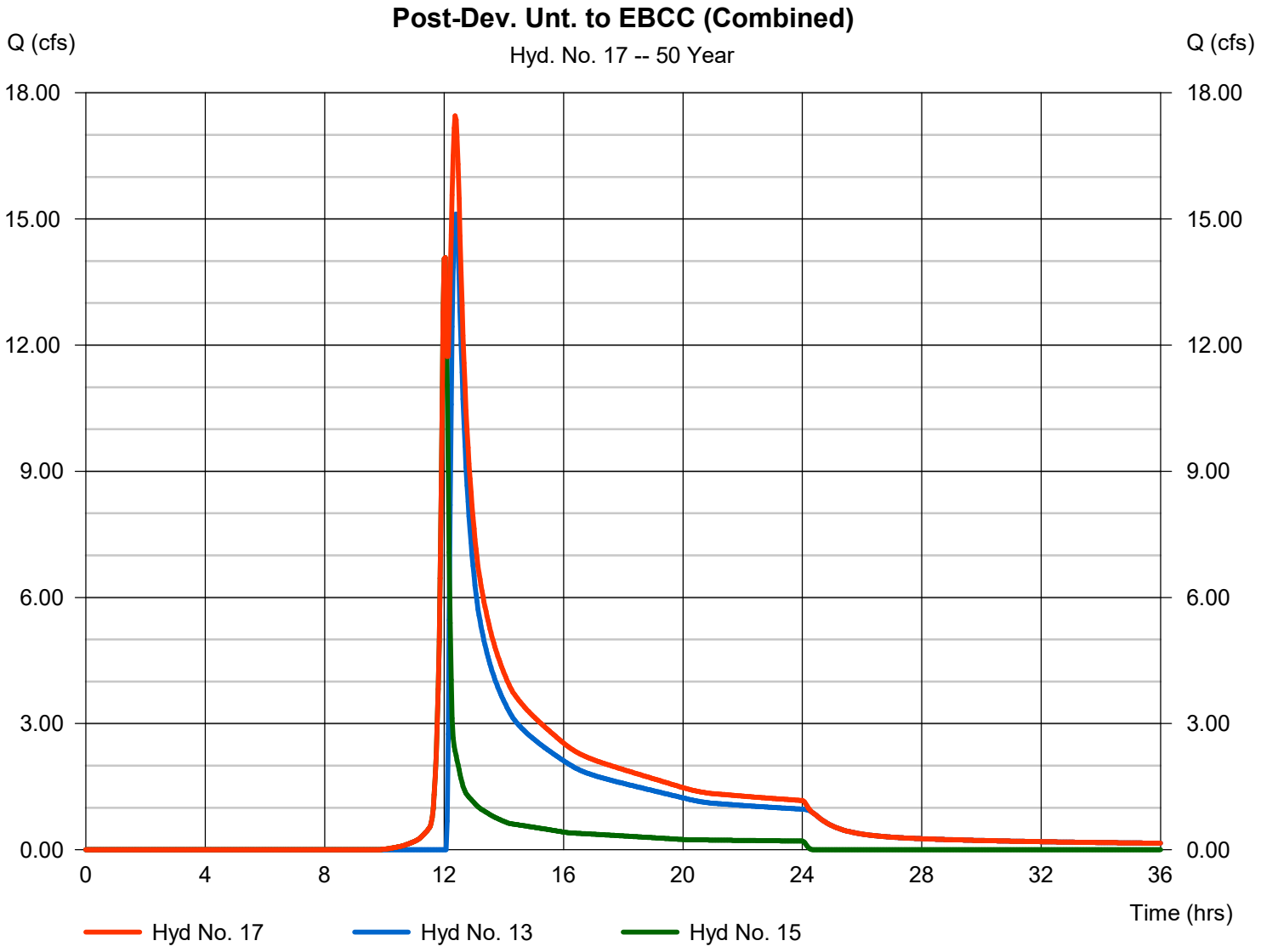


Hydrograph Report

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	=	Combine	Peak discharge	=	17.45 cfs
Storm frequency	=	50 yrs	Time to peak	=	12.37 hrs
Time interval	=	2 min	Hyd. volume	=	166,857 cuft
Inflow hyds.	=	13, 15	Contrib. drain. area	=	3.590 ac

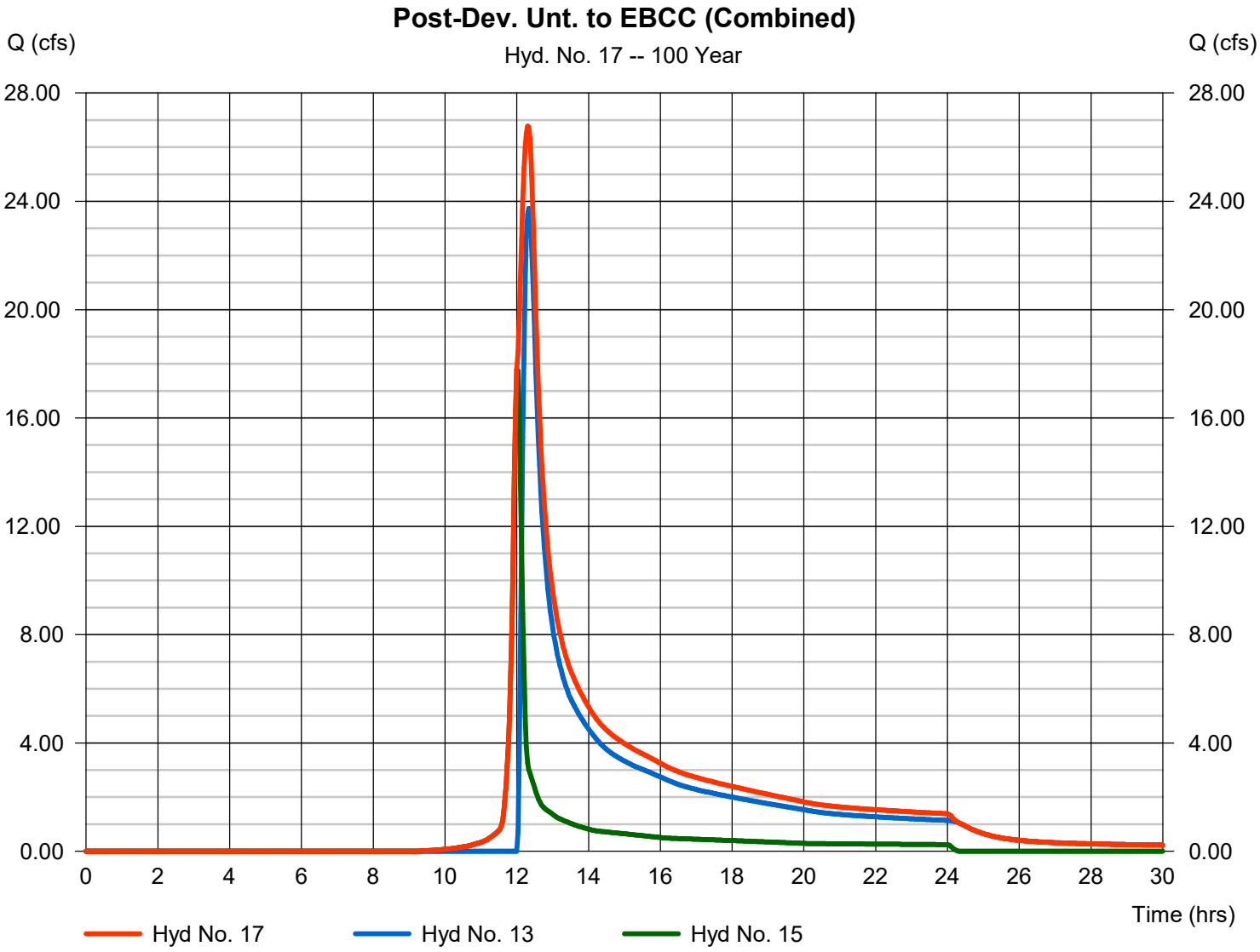


Hydrograph Report

Hyd. No. 17

Post-Dev. Unt. to EBCC (Combined)

Hydrograph type	=	Combine	Peak discharge	=	26.78 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.30 hrs
Time interval	=	2 min	Hyd. volume	=	215,739 cuft
Inflow hyds.	=	13, 15	Contrib. drain. area	=	3.590 ac



APPENDIX F
STORM SEWER CALCULATIONS

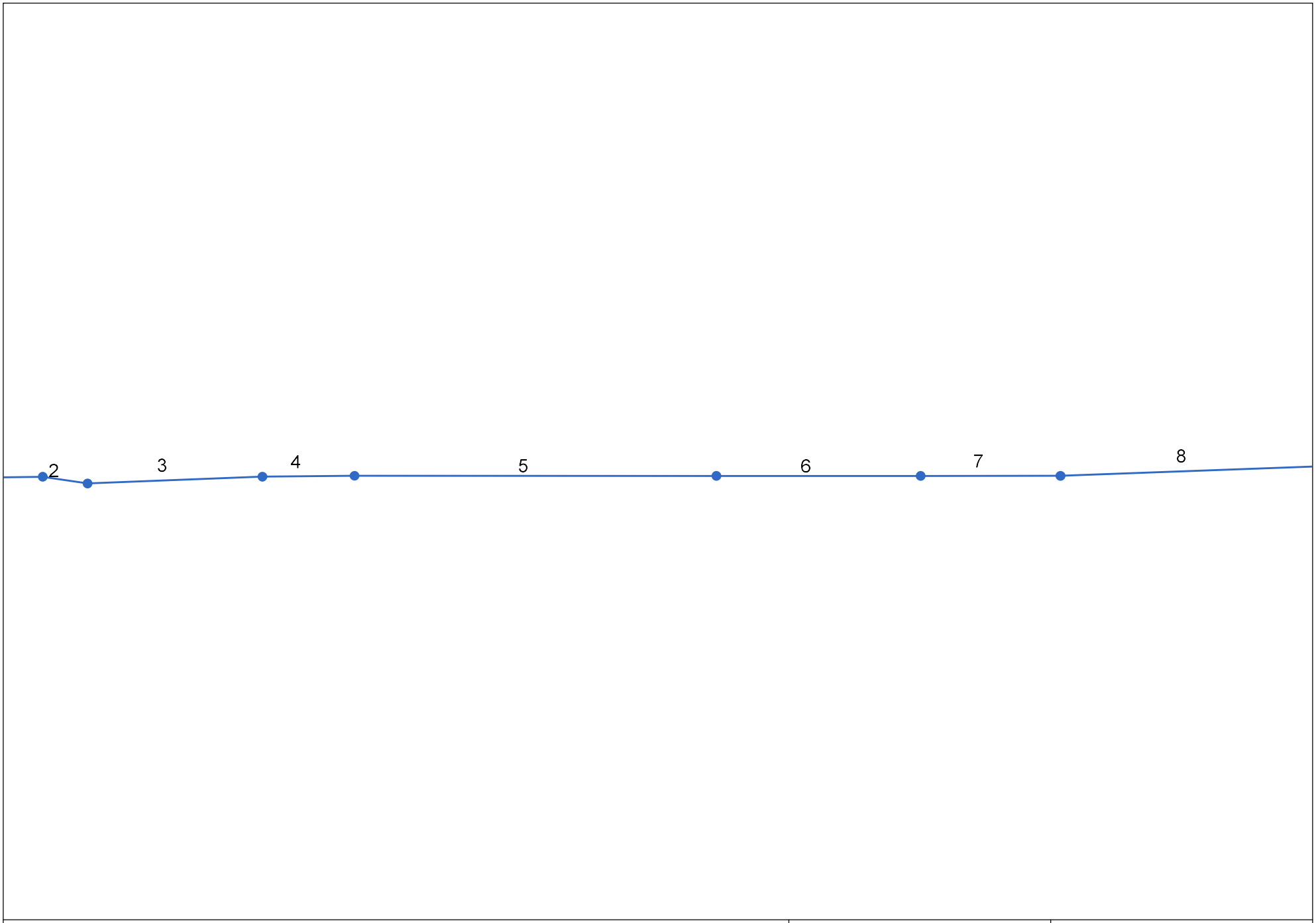
.A GROUP
GINEERS &
NDSCAPE ARCHITECTS
S. BROAD STREET
TZ, PA 17543
') 626-72713

INLET AREA COEFFICIENTS AND SURFACE FLOWS

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

INLET	B SOIL			D SOIL		AREA	COMP.	Tc	COMMENTS
COVER TYPE	IMP	LAWN	WOODS	LAWN	WOODS	(ac.)	C	(min)	
C COEFFICIENTS	0.99	0.25	0.34	0.65	0.7				
I-A3	0.06	1.72	0.00	0.00	0.00	1.79	0.28	5	
I-A5	0.15	0.58	0.00	0.00	0.00	0.73	0.40	5	
I-A6	0.26	0.09	0.00	0.00	0.00	0.35	0.80	5	
I-A7	0.06	0.00	0.00	0.00	0.00	0.06	0.96	5	
I-A8	0.31	0.18	0.00	0.00	0.00	0.48	0.72	5	
I-A9	0.12	0.03	0.00	0.00	0.00	0.15	0.85	5	
I-A10	0.06	0.05	0.00	0.00	0.00	0.11	0.65	5	
I-A11	0.10	0.27	0.00	0.00	0.00	0.37	0.45	5	

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



193

Project File: Westtown-PIPES_A.stm	Number of lines: 9	Date: 9/18/2023

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	68.720	1.79	4.04	0.28	0.50	1.84	5.0	7.4	6.6	12.07	10.52	6.83	18	1.00	288.50	289.19	290.82	291.73	0.00	292.80	A3 to A2
2	1	23.270	0.00	2.25	0.00	0.00	1.34	0.0	7.3	6.6	8.81	18.21	4.99	18	3.01	290.05	290.75	292.09	292.25	292.80	296.20	A4 to A3
3	2	89.010	0.73	2.25	0.40	0.29	1.34	5.0	7.1	6.6	8.91	9.57	5.70	18	0.83	291.00	291.74	292.36	292.89	296.20	295.71	A5 to A4
4	3	46.880	0.35	1.52	0.80	0.28	1.05	5.0	7.0	6.7	7.01	11.63	6.33	15	3.24	291.84	293.36	292.89	294.42	295.71	296.86	A6 to A5
5	4	184.000	0.06	1.17	0.96	0.06	0.77	5.0	6.4	6.9	5.27	13.16	5.07	15	4.15	293.36	301.00	294.42	301.93	296.86	305.00	A7 to A6
6	5	103.890	0.48	1.11	0.72	0.35	0.71	5.0	6.0	7.0	4.95	6.40	5.47	15	0.98	301.10	302.12	301.93	303.02	305.00	306.00	A8 to A7
7	6	71.110	0.15	0.63	0.85	0.13	0.37	5.0	5.8	7.1	2.58	4.65	4.15	12	1.70	302.22	303.43	303.02	304.12	306.00	307.01	A9 to A8
8	7	136.000	0.11	0.48	0.65	0.07	0.24	5.0	5.1	7.3	1.73	3.44	3.72	12	0.93	303.53	304.80	304.12	305.36	307.01	308.37	A10 to A9
9	8	29.850	0.37	0.37	0.45	0.17	0.17	5.0	5.0	7.3	1.22	3.51	3.43	12	0.97	304.90	305.19	305.36	305.65	308.37	308.73	A11 to A10

Project File: Westtown-PIPES_A.stm | Number of lines: 9 | Run Date: 9/18/2023

NOTES:Intensity = 50.00 / (Inlet time + 9.70) ^ 0.72; Return period =Yrs. 100 ; c = cir e = ellip b = box

ELA GROUP
ENGINEERS &
LANDSCAPE ARCHITECTS

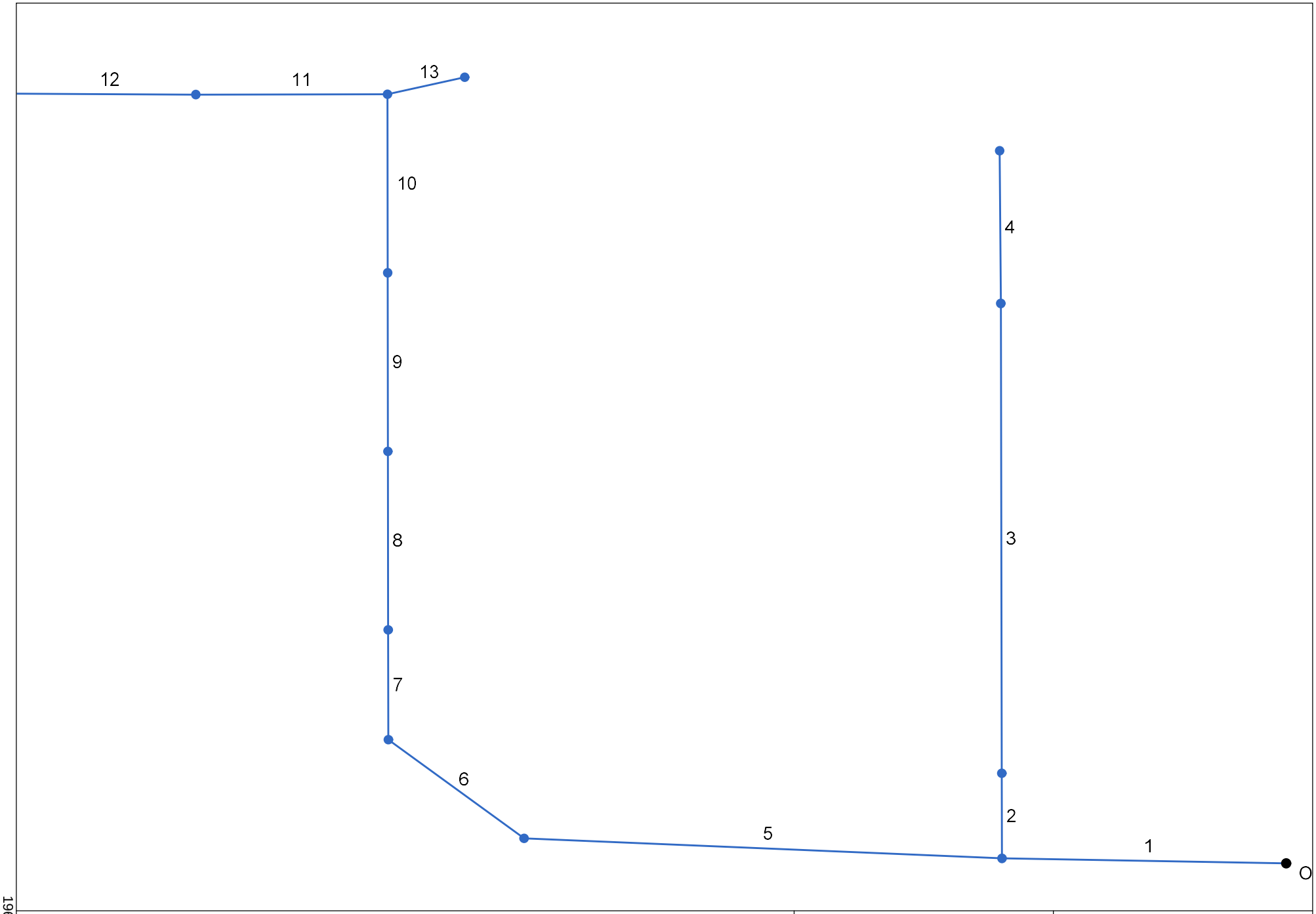
737 S. BROAD STREET
LITITZ, PA 17543
(717) 626-72713

INLET AREA COEFFICIENTS AND SURFACE FLOWS

PROJECT: The Westtown School - Oak Lane Project
LOCATION: Westtown Township
COUNTY: Chester

INLET	TYPE	B SOIL			D SOIL		AREA	COMP.	Tc	COMMENTS
COVER TYPE		IMP	LAWN	CULTIVATED	LAWN	CULTIVATED	(ac.)	C	(min)	
C COEFFICIENTS		0.99	0.25	0.43	0.65	0.67				
I-B4		0.00	0.00	0.00	0.00	0.00	0.00		5	0.25 CFS FROM B-3
I-B5		0.00	0.04	0.00	0.00	0.00	0.04	0.25	5	
I-B6		0.00	0.04	0.00	0.00	0.00	0.04	0.25	5	
I-B8		0.00	0.08	0.00	0.00	0.00	0.08	0.25	5	0.92 CFS FROM B-2
I-B9		0.00	0.12	0.00	0.00	0.00	0.12	0.25	5	
I-B10		0.06	0.05	0.00	0.00	0.00	0.11	0.65	5	
I-B11		0.01	0.09	0.00	0.00	0.00	0.11	0.33	5	
I-B12		0.08	0.13	0.00	0.00	0.00	0.21	0.54	5	
I-B12A		0.01	0.02	0.00	0.00	0.00	0.03	0.57	5	
I-B13		0.01	0.04	0.00	0.00	0.00	0.05	0.45	5	
I-B14		0.02	0.02	0.00	0.00	0.00	0.03	0.61	5	
I-B18		0.15	0.86	0.35	0.00	0.00	1.35	0.38	5	

Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan



196

Project File: Westtown-PIPES_B.stm	Number of lines: 13	Date: 9/18/2023

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	148.240	0.00	0.82	0.00	0.00	0.35	5.0	11.6	5.6	4.51	4.59	3.73	15	0.51	310.00	310.75	311.25	311.91	0.00	316.00	MH-B3 TO EW-B2
2	1	44.610	0.00	0.08	0.00	0.00	0.02	5.0	7.2	6.6	0.57	11.74	1.72	12	10.87	311.15	316.00	312.13	316.31	316.00	322.25	I-B4 TO MH-B3
3	2	246.000	0.04	0.08	0.25	0.01	0.02	5.0	6.0	7.0	0.58	1.28	3.30	8	1.12	316.25	319.00	316.57	319.36	322.25	322.25	OCS-3 TO I-B4
4	3	80.000	0.04	0.04	0.25	0.01	0.01	5.0	5.0	7.3	0.07	1.22	1.36	8	1.01	319.19	320.00	319.36	320.12	322.25	322.00	I-B6 TO OCS-3
5	1	249.540	0.00	0.74	0.00	0.00	0.33	5.0	10.4	5.8	4.03	4.57	3.48	15	0.50	310.75	312.00	312.13	313.05	316.00	321.00	MH-B7 TO MH-B3
6	5	87.620	0.08	0.74	0.25	0.02	0.33	5.0	10.0	5.9	4.06	4.88	3.73	15	0.57	312.00	312.50	313.17	313.45	321.00	317.00	OCS-2 TO MH-B7
7	6	57.500	0.12	0.66	0.25	0.03	0.31	5.0	9.6	6.0	1.86	2.66	2.37	12	0.56	312.50	312.82	313.77	313.93	317.00	317.00	I-B9 TO OCS-2
8	7	93.500	0.11	0.54	0.65	0.07	0.28	5.0	8.9	6.2	1.72	2.52	2.28	12	0.50	312.82	313.29	313.97	314.17	317.00	317.00	I-B10 TO I-B9
9	8	93.500	0.11	0.43	0.33	0.04	0.21	5.0	8.3	6.3	1.31	1.55	2.47	10	0.50	313.29	313.76	314.21	314.52	317.00	317.00	I-B11 TO I-B10
10	9	93.500	0.21	0.32	0.54	0.11	0.17	5.0	7.7	6.5	1.11	1.55	2.43	10	0.50	313.76	314.23	314.57	314.80	317.00	317.00	I-B12 TO I-B11
11	10	100.000	0.05	0.08	0.45	0.02	0.04	5.0	6.3	6.9	0.28	0.85	1.17	8	0.50	314.23	314.73	314.98	315.08	317.00	317.00	I-B13 TO I-B12
12	11	100.000	0.03	0.03	0.61	0.02	0.02	5.0	5.0	7.3	0.13	0.87	1.31	8	0.52	314.73	315.25	315.10	315.42	317.00	317.00	I-B14 TO I-B13
13	10	41.260	0.03	0.03	0.57	0.02	0.02	5.0	5.0	7.3	0.12	0.86	0.38	8	0.51	314.23	314.44	314.98	314.99	317.00	318.65	I-B12A TO I-B12

Project File: Westtown-PIPES_B.stm | Number of lines: 13 | Run Date: 9/18/2023

NOTES:Intensity = 50.00 / (Inlet time + 9.70) ^ 0.72; Return period =Yrs. 100 ; c = cir e = ellip b = box

APPENDIX G
SPILLWAY/ANTI-SEEP COLLAR DESIGN CALCULATIONS

BMP 1 EMERGENCY SPILLWAY

PROJECT:	The Westtown School - Oak Lane Project	JOB #	1091-001
LOCATION:	Westtown Township	DATE:	1/12/2023
COUNTY:	Chester	REVISED:	9/17/2023

Flow into basin for 100-year storm frequency:

Q = 29.58 cfs cfs (From Post-Development analysis)

Capacity of the Emergency Spillway:

Q = CLH^1.5

C = 2.8
L = 30 ft.
H = 1.00

Q = 84.00 cfs > 30 cfs cfs OK

Check actual depth and velocity:

Top of Berm Elevation = 293.00
Spillway Elevation = 291.25

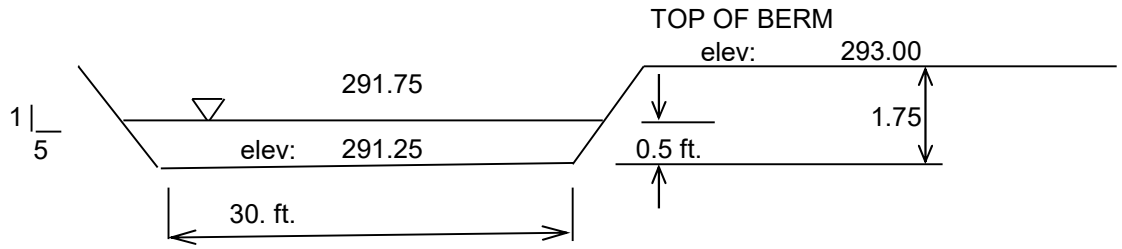
H = [Q/C*L]^2/3

= 0.5 ft. at elevation 291.75

Freeboard: 293.00 - 291.75 = 1.25 ft.

V = Q/A Side Slope (H:V) = 4.5

= 1.8 fps



N.T.S.

BMP 4 EMERGENCY SPILLWAY

PROJECT:	The Westtown School - Oak Lane Project	JOB #	1091-001
LOCATION:	Westtown Township	DATE:	1/12/2023
COUNTY:	Chester	REVISED:	9/17/2023

Flow into basin for 100-year storm frequency:

Q = 38.87 cfs cfs (From Post-Development analysis)

Capacity of the Emergency Spillway:

Q = CLH^1.5

C = 2.8
L = 40 ft.
H = 1.00

Q = 112.00 cfs > 39 cfs cfs OK

Check actual depth and velocity:

Top of Berm Elevation = 315.00
Spillway Elevation = 313.00

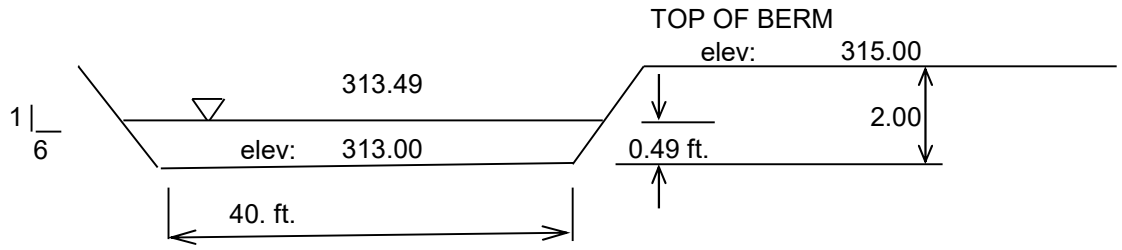
H = [Q/C*L]^2/3

= 0.49 ft. at elevation 313.49

Freeboard: 315.00 - 313.49 = 1.51 ft.

V = Q/A Side Slope (H:V) = 6

= 1.8 fps



N.T.S.

MODIFIED WORK SHEET # 11

SPILLWAY STABILITY CALCULATIONS

PROJECT:	The Westtown School - Oak Lane Project	JOB #	1091-001
LOCATION:	Westtown Township	Date	9/18/23
COUNTY:	Chester	Revised	

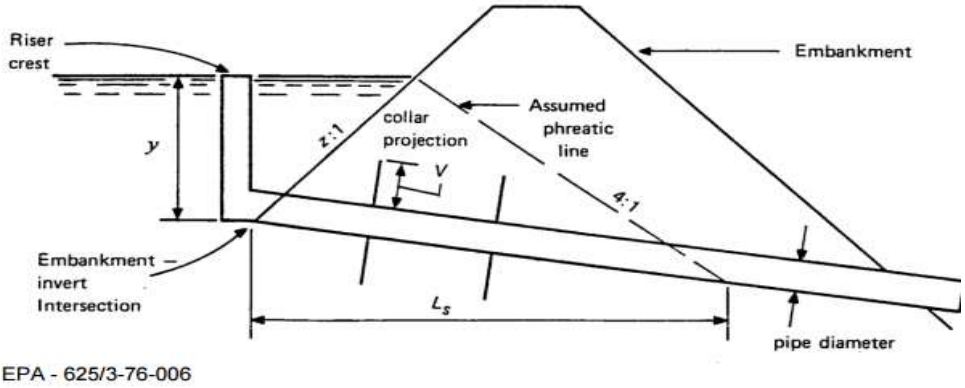
x	BASIN SPILLWAY ID		BMP 1	BMP 4		
	TEMPORARY OR PERMANENT?	(T OR P)	P	P		
	DESIGN STORM		100	100		
	Qr (REQUIRED CAPACITY)*	(CFS)	29.58	38.61		
	Q (CALCULATED AT FLOW DEPTH d)	(CFS)	29.59	38.62		
x	PROTECTIVE LINING[2]		Flexamat	Flexamat		
	n (MANNING'S COEFFICIENT)[2]		0.058	0.059		
	Va (ALLOWABLE VELOCITY)	(FPS)	19	19		
	V (CALCULATED AT FLOW DEPTH d)	(FPS)	4.05	4.69		
	ta (MAX ALLOWABLE SHEAR STRESS)	(LB/FT^2)	24.00	24.00		
	td (CALC'D SHEAR STRESS AT FLOW DEPTH d)	(LB/FT^2)	2.49	3.62		
	SPILLWAY BOTTOM WIDTH	(FT)	30.0	40.0		
	SIDE SLOPES	(H:V)	4.5:1	6:1		
	D (TOTAL DEPTH)	(FT)	1.75	2.00		
	d (CALCULATED FLOW DEPTH)	(FT)	0.24	0.20		
x	d_{50} STONE SIZE (IN)	(IN)	N/A	N/A		
x	A (CROSS-SECTIONAL AREA)	(SQ. FT.)	7.30	8.23		
x	R (HYDRAULIC RADIUS)		0.24	0.20		
x	S (BED SLOPE)[3]	(FT/FT)	0.167	0.286		
x	FREEBOARD PROVIDED	(FT)	1.51	1.80		
x	DESIGN METHOD FOR PROTECTIVE LINING **** PERMISSIBLE VELOCITY (V) OR SHEAR STRESS (S)		S	S		

ANTI-SEEP COLLAR DESIGN

Infiltration BMP 1/Sediment Trap 1

PA DEP

FIGURE 7.6
Anti-seep Collar Design



EPA - 625/3-76-006

1. Determine length of pipe in saturated zone (Ls)

$$L_s = y(z+4)\left[1+\frac{S}{(0.25-S)}\right]$$

y =	6.25
z =	3
s=	0.005

Where y = Distance from upstream invert of spillway riser to top of dewatering volume (ft)
z = Horizontal component of upstream embankment slope (ft)
S = Pipe slope ft/ft

L_s = 44.64 ft

2. Determine the required increase in flow path

$L_F = 1.15 * L_s$ = 51.34 ft

3. The minimum collar projection (V) is equal to 1/2 the increase in flow length (for one collary). If more than one collar is used, it is the increase divided by twice the number of collars

Number of collars: 2

Vmin = 1.67 ft

4. The maximum spacing between collars should be 14 x V or Ls ÷ (number of collars minus 1)

Minimum spacing should be 5 X V

V = 1.67 ft

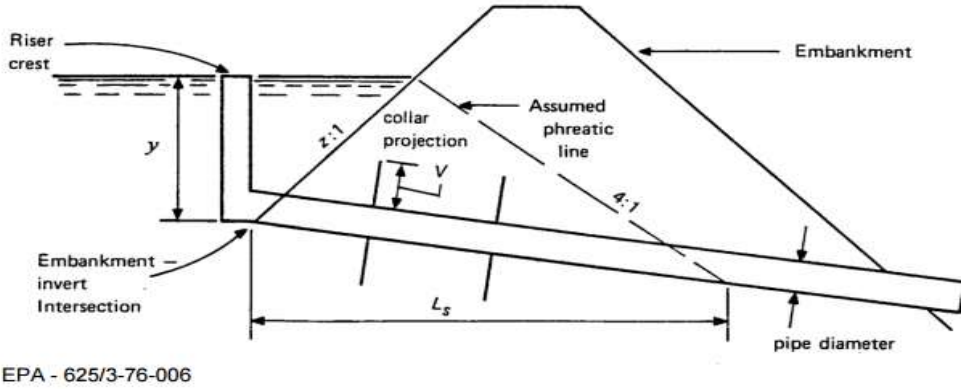
Max = 22 ft
Min = 8.4 ft

ANTI-SEEP COLLAR DESIGN

Infiltration BMP 4/Sediment Basin 4

PA DEP

FIGURE 7.6
Anti-seep Collar Design



EPA - 625/3-76-006

1. Determine length of pipe in saturated zone (Ls)

$$L_s = y(z+4)\left[1+\frac{S}{(0.25-S)}\right]$$

y =	3.75
z =	3
s=	0.0069

Where y = Distance from upstream invert of spillway riser to top of dewatering volume (ft)
z = Horizontal component of upstream embankment slope (ft)
S = Pipe slope ft/ft

L_s = 27.00 ft

2. Determine the required increase in flow path

$L_F = 1.15 * L_s$ = 31.04 ft

3. The minimum collar projection (V) is equal to 1/2 the increase in flow length (for one collary). If more than one collar is used, it is the increase divided by twice the number of collars

Number of collars: 1

Vmin = 2.00 ft

4. The maximum spacing between collars should be 14 x V or Ls ÷ (number of collars minus 1)

Minimum spacing should be 5 X V

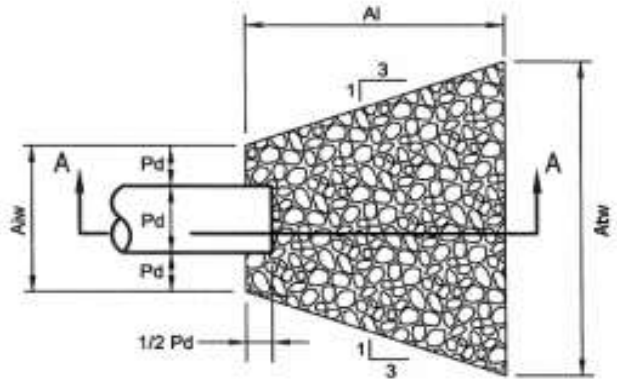
V = 1 ft

Max = 14 ft
Min = 5 ft

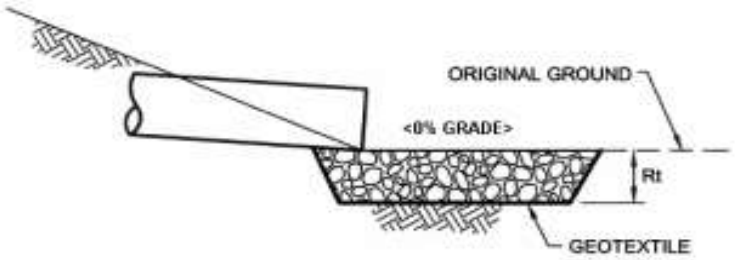
APPENDX H
RIP-RAP DESIGN CALCULATIONS

STANDARD E&S WORKSHEET #20
Riprap Apron Outlet Protection

PROJECT:	The Westtown School - Oak Lane Project	JOB #	1091-001
LOCATION:	Westtown Township	DATE:	1/16/2023
COUNTY:	Chester	REVISED:	9/19/2023
CHECKED BY:			



PLAN VIEW

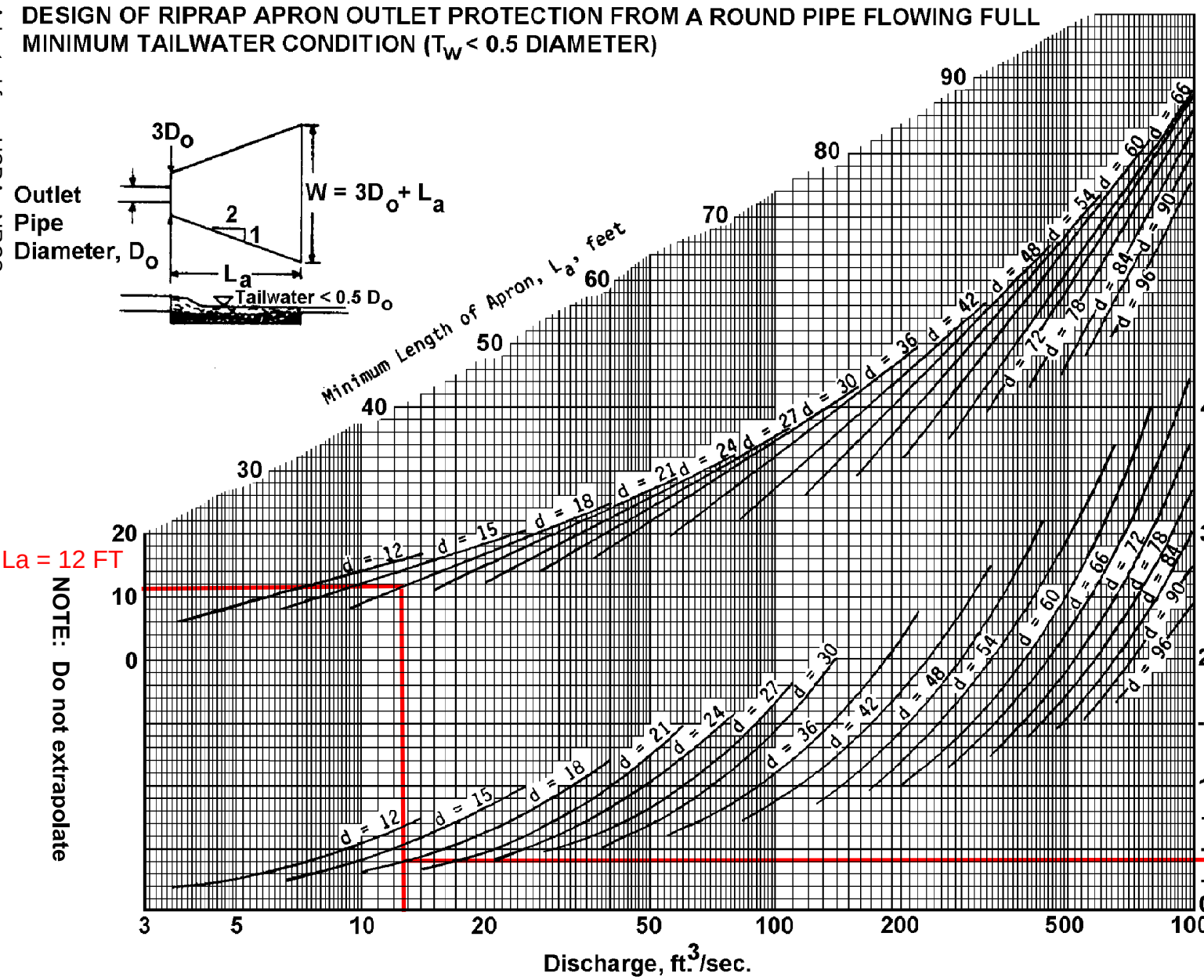


SECTION A - A

NO.	PIPE DIA. Do (in.)	TAIL WATER COND. (Max or Min.)	MAN. "n" FOR PIPE	PIPE SLOPE (%)	Q (CFS)	V* (FPS)	RIPRAP SIZE	Rt (in)	Al (ft)	Aiw (ft)	Atw (ft)
EW-A1	18	Min.	0.012	0.50	11.5	6.49	R-4	18	12	4.50	16.50
EW-A2	18	Min.	0.012	1.00	12.0	6.83	R-4	18	12	4.50	16.50
EW-B1	24	Min.	0.012	0.67	23.7	7.56	R-4	18	14	6.00	20.00
EW-B2	15	Min.	0.012	0.51	4.51	3.73	R-3	9	9	3.75	12.75

*The anticipated velocity (V) should not exceed the maximum permissible shown in Table 6.6 for the proposed riprap protection. Adjust for less than full pipe flow. SEE TABLE 9, March 2000 E&S PROGAM MANUAL. Use Manning's equation to calculate velocity for pipe slopes > 0.05 ft/ft.velocity for pipe slopes > 0.05 ft/ft.
** Based on sediment basin flow through principle spillway
*** See attached Hydraflow Storm Sewers

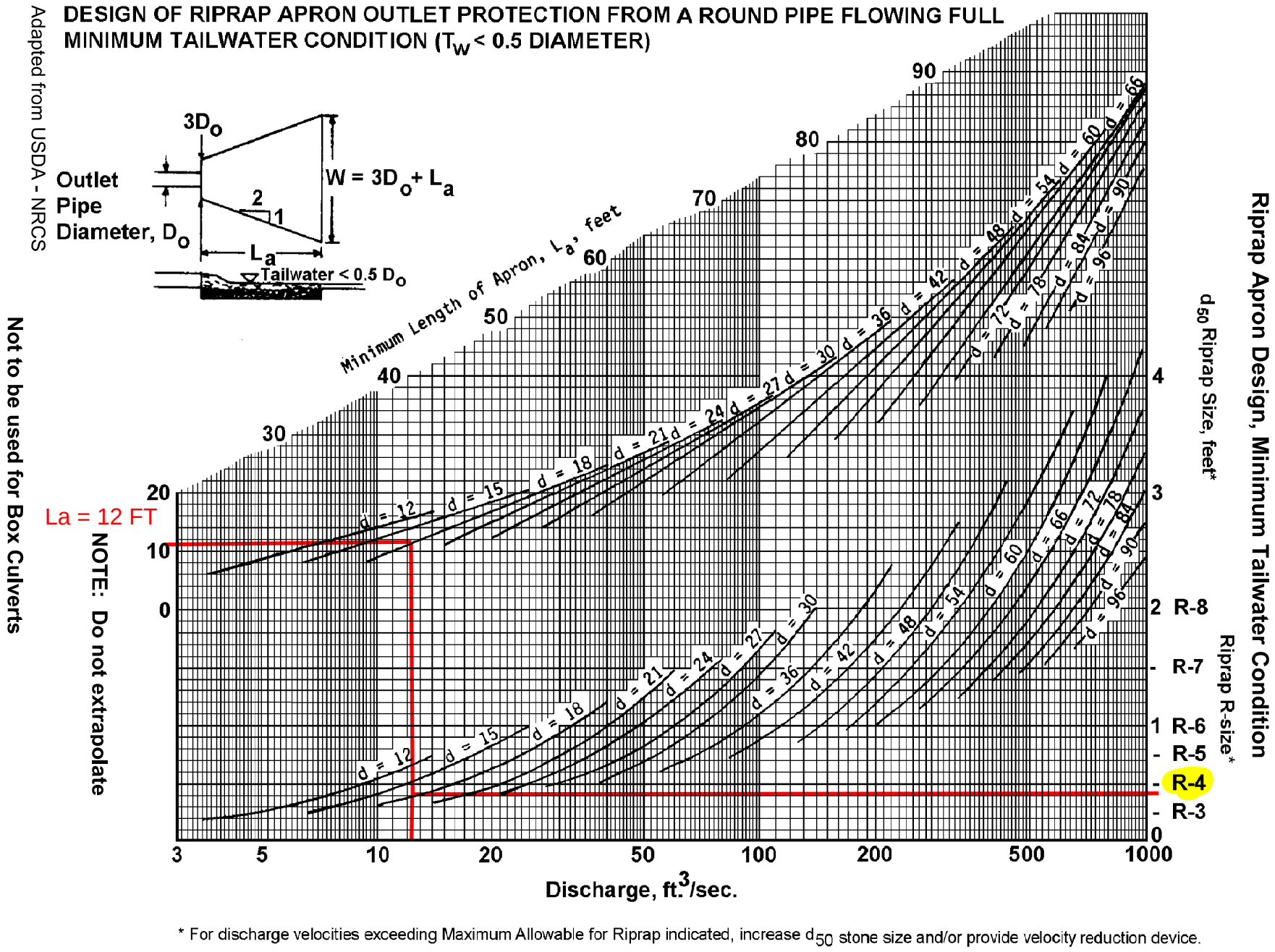
EW-A1



* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

EW-A2



* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

EW-B1

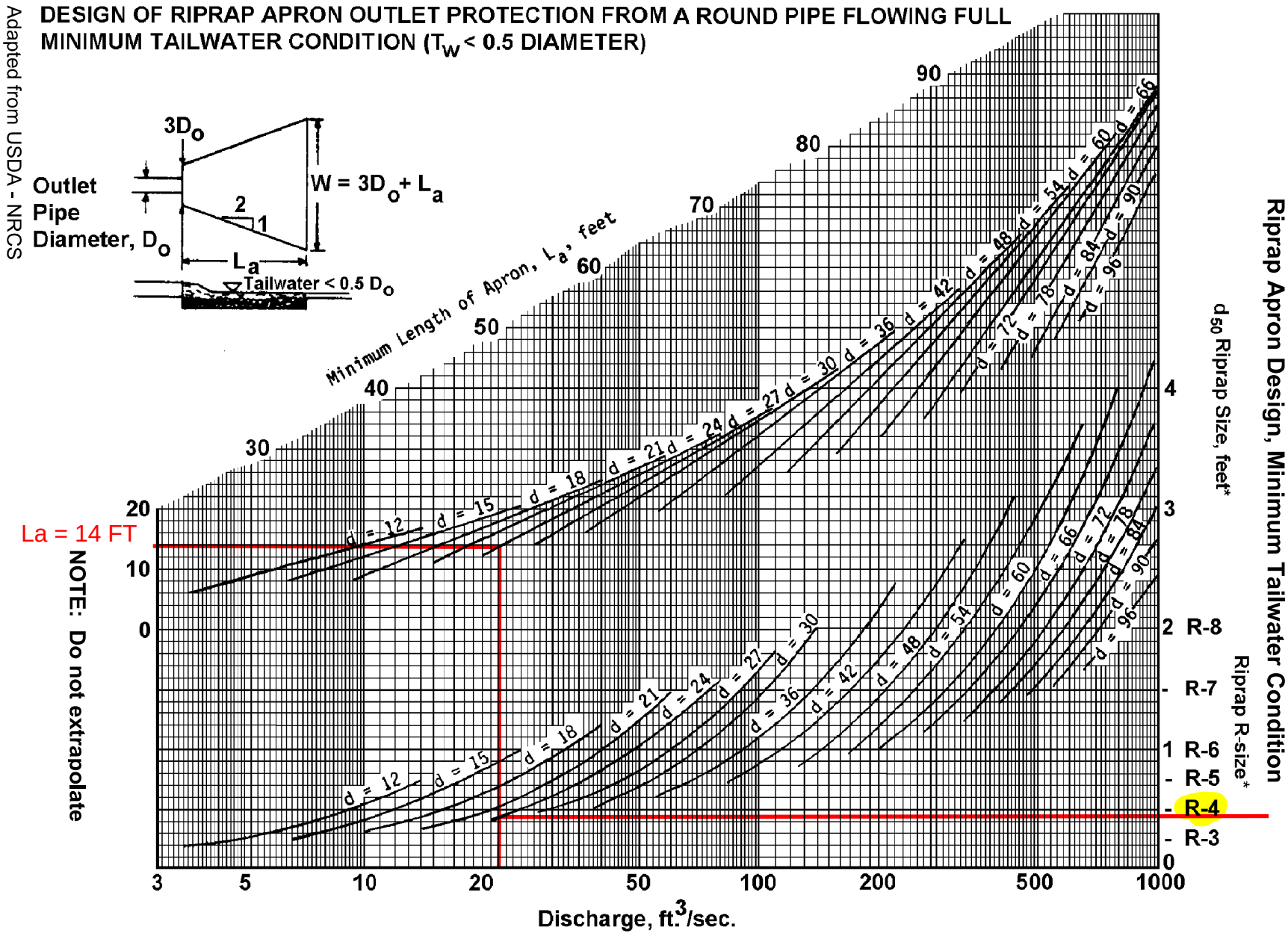
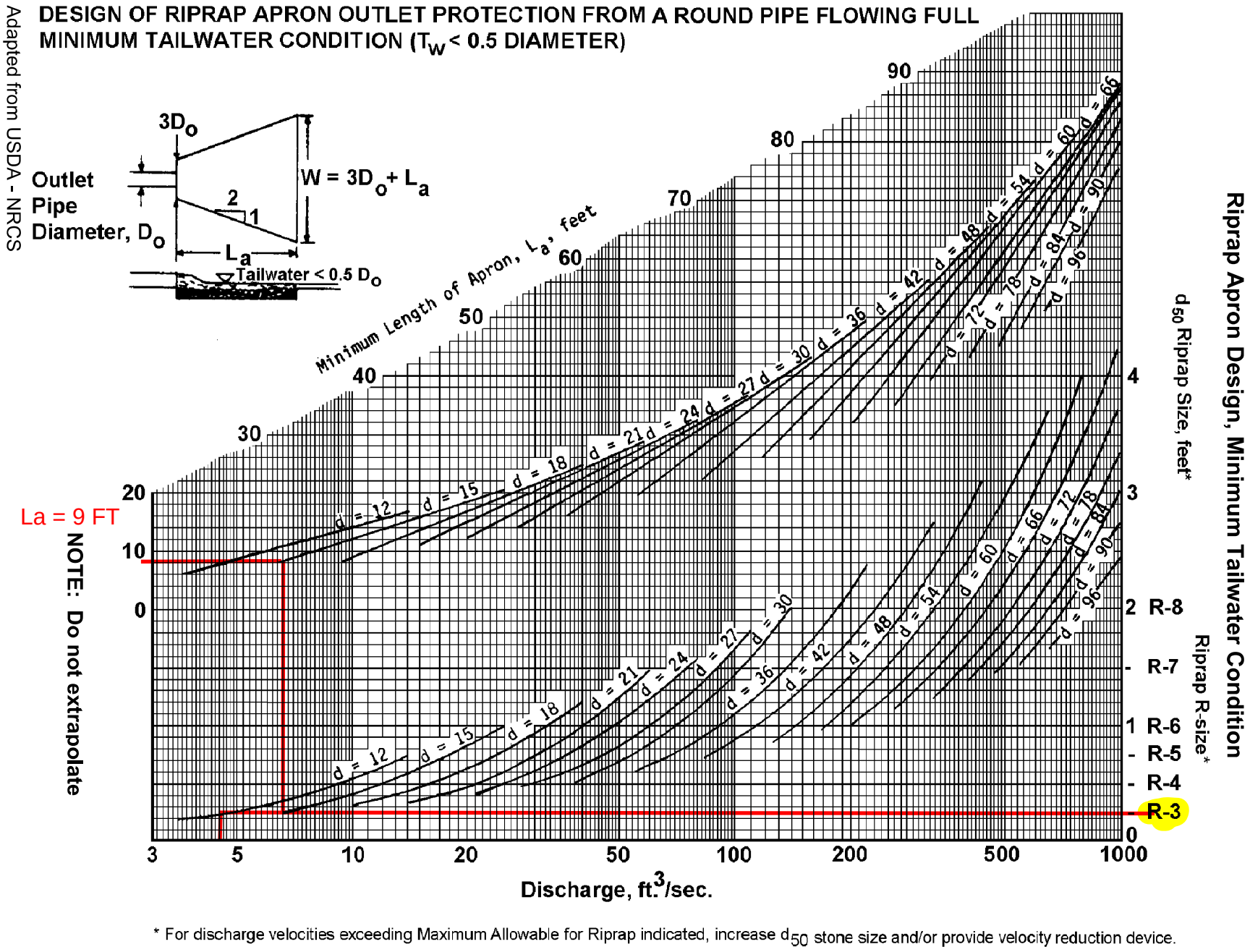


FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

EW-B2



* For discharge velocities exceeding Maximum Allowable for Riprap indicated, increase d_{50} stone size and/or provide velocity reduction device.

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition

Anticipated Velocity Calculation for Less Than Full Pipe Flow

Outfall EW-B2

Full Flow Discharge: $Q_f = \frac{0.464}{n} D^{8/3} S^{1/2}$ = 5.01 cfs

Continuity Equation to determine full-flow velocity:

$$V_f = \frac{Q_f}{A} = 4.08 \text{ ft/sec}$$

Where: A = 1.23 = Cross Sectional Area (ft^2)

Ratio of Partial to Full-Flow Discharge:

$$d/D = \frac{Q_d}{Q_f} = 0.899$$

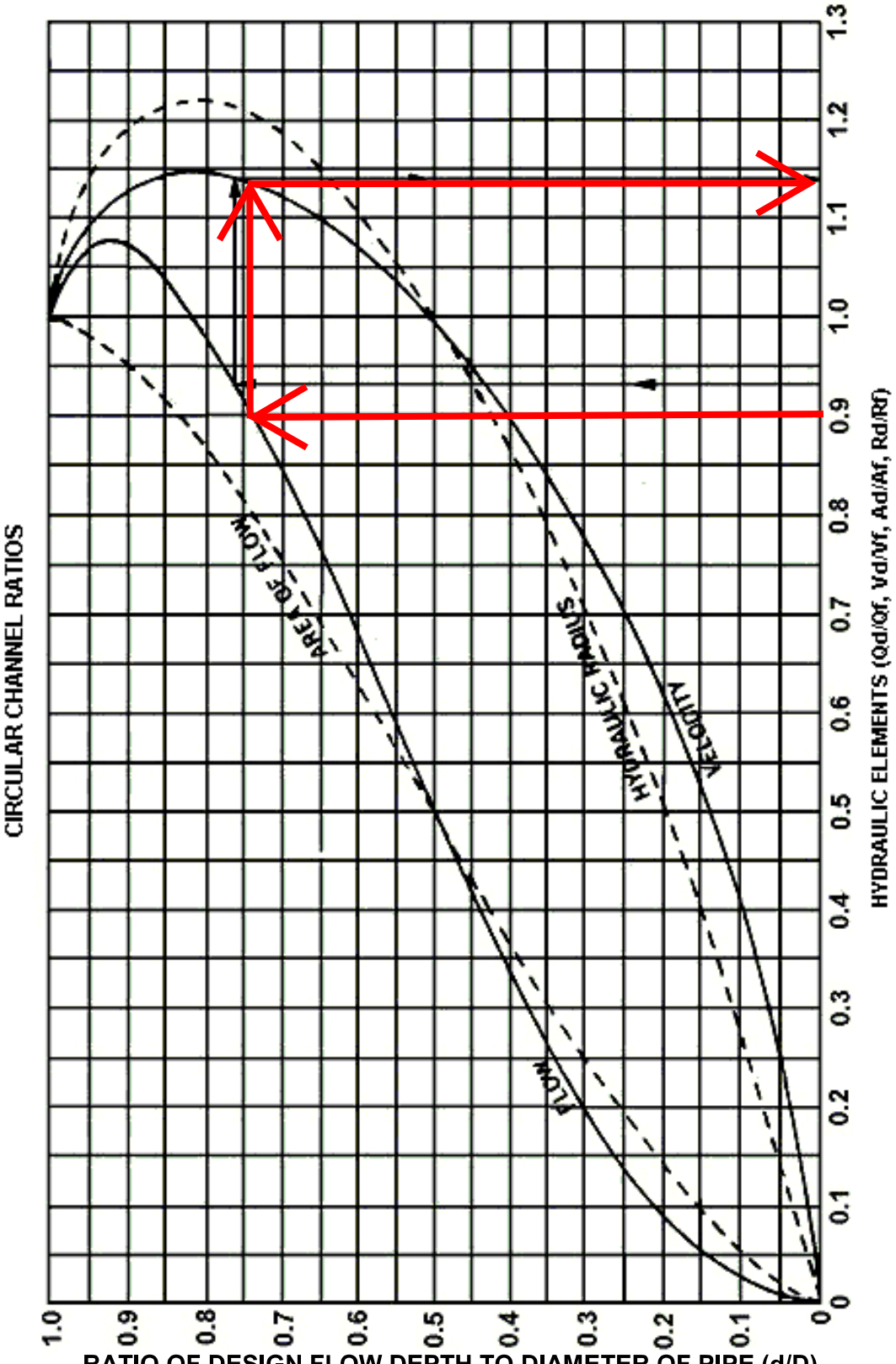
Where:	d/D =	0.90	= Ratio of Part-Full to Full-Flow Discharge
	Qd =	4.50	= Design Discharge (cfs)
	Qf =	5.01	= Full-Flow Discharge (cfs)
	D =	1.25	= Diameter (ft)
	S =	0.01	= Slope of pipe (ft/ft)
	n =	0.012	= Mannings Coefficient

Velocity Ratio from Figure 9.1: 1.14

Design Velocity V_d = 4.65 ft/s

EW-B2

FIGURE 9.1
Velocity Adjustment Nomograph for Less Than Full Pipe Flow



Adapted from *Design and Construction of Sanitary and Storm Sewers,* p. 87, ASCE, 1969

Do not use this nomograph to determine "equivalent pipe sizes" for discharges (Q_d) that do not intersect curves corresponding to proposed pipe sizes on Figures 9.3 and 9.4.

APPENDIX I
INFILTRATION REPORTS

October 8, 2018

Westtown School
975 Westtown Road
West Chester, PA 19382

c/o

Mr. Charles R. Haley, Jr., P.E.
ELA Group, Inc.
743 South Broad Street
Lititz, PA 17543

RE: Stormwater Infiltration Feasibility Report
Westtown School Oak Lane – Infiltration
Westtown Township, Chester County, Pennsylvania
Advantage Project Number: 1800331001

Dear Mr. Haley:

In accordance with your request, Advantage Engineers (Advantage) has completed an engineering analysis of the above referenced project site in order to evaluate the suitability of the subsurface soils for the infiltration of stormwater. This correspondence serves to transmit the results of our evaluation.

SITE AND PROJECT DESCRIPTION

The project site currently consists of outdoor athletic fields located east of Westtown Road in Westtown Township, Chester County, Pennsylvania. The site is bordered to the east by agricultural land and grass areas, to the south by Westtown School District buildings, to the west by Westtown Road and to the north by Westtown School District and wooded areas. The approximate location of the site in relation to the surrounding area is depicted on the *Topographic Map* (Figure 1) presented within the Appendix.

According to information provided by the Client, the improvements will include 2 synthetic turf multipurpose fields, 2 grass multipurpose fields, a softball field and a baseball field. Development of the site will also include new field lights, an outbuilding and new stormwater management facilities.

SCOPE OF WORK

The objective of our work was to determine the permeability of the invert soils, identify any limiting zones (i.e. bedrock, groundwater, or seasonal high water table) within the proposed stormwater management facilities, and address PADEP requirements as they relate to stormwater management. This objective was accomplished through completion of a scope of work which included the completion of a subsurface field exploration, laboratory testing program and preparation of this report. This report presents a summary of the scope of work completed, conditions encountered, and results of our engineering analysis of subsurface conditions.

SUBSURFACE FIELD EXPLORATION

In order to characterize subsurface conditions across the project site, 13 test pits were excavated on September 26 through 28, 2018. Supervision and monitoring of the field exploration was provided by a representative of Advantage. Test locations were marked out by ELA Group, Inc., based on the “Sketch Plan”, dated July 24, 2017, prepared by Site Engineering Concepts, LLC. The approximate test locations, referenced as TP-1 through TP-13, are shown on the *Exploration Plan* (Figure 3) presented within the Appendix. Data pertaining to the subsurface exploration was documented in the field and is presented in detail on the *Test Pit Logs*, which contain detailed descriptions of the subsurface materials encountered and infiltration test depths. A general description of the soil conditions encountered is provided in the “Subsurface Conditions” section of this report.

LABORATORY ANALYSIS

Soil samples retrieved from the site were visually reviewed and classified by Advantage Engineers. Representative soil samples were subjected to laboratory analyses to verify visual classifications in accordance with the following schedule:

- Natural Moisture Content (ASTM D2216)
- Sieve Analysis (ASTM D422)
- Atterberg Limits Determination (ASTM D4318)

Unified Soil Classification System (USCS) Group Symbols and ASTM Group Names has been assigned to the soils analyzed. Graphical depictions of the laboratory testing completed are presented in the table below and within the Appendix.

STANDARD CLASSIFICATION RESULTS											
Location	**Depth (ft)**	**Soil Type**	**% Gravel**	**% Sand**	**% Fines**	**LL**	**PL**	**PI**	**Natural Moisture Content**	**USCS Group Symbol**	**ASTM Group Name**
TP-2	3	Stratum I	7.2	54.4	38.4	36	33	3	21.9%	SM	Silty SAND
TP-5	4 – 6		45.6	42.5	11.9	36	35	1	10.7%	GP-GM	Poorly Graded GRAVEL with Silt and Sand

LL-Liquid Limit; PL-Plastic Limit; PI-Plasticity Index

SUBSURFACE CONDITIONS

Geology

According to the Pennsylvania Geologic Survey's, Geologic Map of the State of Pennsylvania, 1980, the project site is underlain by politic schist of the Glenarm Wissahickon Formation (Geologic Symbol Xgw). This formation includes lenticular amphibolites bodies having ocean-floor basalt chemistry. The project site within its geologic setting is presented on the G*eologic Map* (Figure 2) found within the Appendix.

The Pennsylvania Geologic Survey publication, The Engineering Characteristics of the Rocks of Pennsylvania, Second Edition, 1982, describes the bedding in this formation as well developed, thin to fissile, and steeply dipping. Joints in this formation have an irregular pattern, are poorly formed, widely spaced, steeply dipping, and open. The schist of this formation is moderately resistant to weathering, and often weathers to a moderate depth. The resulting soil mantle is thin.

Soil

Surficial Materials

Each test pit was covered by approximately 6 to 28 inches of topsoil or tilled soil; however, the thickness of surficial materials may differ in unexplored areas of the project site.

Stratum I – Brown to gray Silty SAND and GRAVEL with Silt and Sand

Stratum I was encountered within each test pit completed except for TP-12 and TP-13 and extended to depths ranging from approximately 4.5 to 10 feet below existing site grades. Laboratory testing conducted on representative samples of Stratum I show this soil to be well graded and non-plastic with natural moisture contents of 21.9% and 10.7%. Stratum I is described under the USCS as Silty SAND (SM) and Poorly Graded GRAVEL with Silt and Sand (GP-GM).

Stratum II – Brown Silty SAND with Gravel (highly weathered rock)

Stratum II was encountered within test pits TP-10 and TP-11 and extended to depths of approximately 7.5 and 9.5 feet, respectively, below existing site grades. Upon review, the soils of Stratum II were found to be well graded, non-plastic and predominately comprised of Silty SAND with Gravel. The soils of Stratum II are anticipated to represent the highly weathered bedrock surface.

Stratum III – Orange brown to blue gray Sandy CLAY

Stratum III was encountered within test pits TP-12 and TP-13 and extended to depths of approximately 6 feet below existing site grades. Upon review, the soils of Stratum III were found to be moderately graded, plastic and comprised of Sandy CLAY.

Bedrock

The bedrock surface was encountered within test pits TP-10 and TP-11 at depths of approximately 7.5 and 9.5 feet below existing site grades, respectively. The bedrock surface was defined as the depth at which the bucket of the given excavation equipment could no longer excavate. Other equipment may yield different bedrock data.

Groundwater/Soil Mottling

Groundwater was encountered within test pits TP-7, TP-8, TP-12 and TP-13 at depths ranging from approximately 1.5 to 6 feet below existing site grades. Additionally, soil mottling (indication of seasonal high water table and/or poorly draining soils) was encountered within test pits TP-12 and IT-13, starting at a depth of approximately 2.5 feet below existing site grades and extending to 6 feet below existing site grades. It should be noted that standing water was observed at several areas including the agricultural field located in the eastern portion of the site and the portion of the site located north of Oak Lane. These observations were made at the time of the field operation and the groundwater table elevation will vary with daily, seasonal, and climatological variations.

INFILTRATION ANALYSIS

To evaluate the feasibility of infiltration of stormwater within the proposed stormwater management facilities, infiltration tests were completed utilizing the “double-ring” infiltrometer method in accordance with the Pennsylvania Stormwater Best Management Practices Manual, latest Edition. Based on the topsoil thickness encountered within test pit TP-4, the infiltration test was completed below the proposed test elevation. Based on the limiting zone encountered (groundwater and/or soil mottling) within test pits TP-8, TP-12 and TP-13, no infiltration tests were able to be completed. Based on the limiting zones encountered (groundwater/bedrock) within TP- 7, TP-10 and TP-11, the infiltration tests were completed above the proposed test elevations. The test pit locations, approximate surface elevation, proposed test elevation, actual test elevation(s), presence of limiting zones, and the infiltration rate(s) achieved at each location are presented in the table below.

INFILTRATION TEST RESULTS					
Test Location	**Surface Elevation (ft)**	**Proposed Test Elevations (ft)**	**Actual Test Elevations (FT)**	**Limiting Zone Elevation (ft)**	**Infiltration Rate* (in/hr)**
TP-1	319.5	316	316	Not Encountered @ 312	1.8
		314	314		6.0
TP-2	317	316	316	Not Encountered @ 312	0.0
		314	314		1.4
TP-3	321	317.5	317.5	Not Encountered @ 313.5	6.0
		315.5	315.5		12.0
TP-4	319.5	319	318.5	Not Encountered @ 315	1.2
		317	317		1.0
TP-5	321	319.5	319.5	Not Encountered @ 315	3.4
		317	317		4.8
TP-6	311	309	309	Not Encountered @ 305	1.0
		307	307		0.0
TP-7	313	309	311	Groundwater @ 307	0.0
		307	309		2.8
TP-8	311	309	No Test	Groundwater @ 309.5	No Test
		307	No Test		No Test
TP-9	**303**	**292.5**	**295**	**Not Encountered @ 293**	**3.9**
		291	**295**		**4.0**
TP-10	305	299	301	Bedrock @ 297.5	2.8
		297	299.5		4.8
TP-11	309	303	303	Bedrock @ 299.5	6.0
		301	301.5		5.4
TP-12	298	296	No Test	Soil Mottling @ 295.5-292 Groundwater @ 294.5	No Test
		294	No Test		No Test
TP-13	286	284	No Test	Groundwater @ 284.5 Soil Mottling @ 283.5-280	No Test
		282	No Test		No Test

**Infiltration rates represent the rates recorded in the field and no safety factor has been applied*
-Shaded cells represent infiltration tests completed above or below proposed invert due to a limiting zone or topsoil thickness
-Bold cells indicate infiltration testing completed at shallower depths due to safety concerns

SUMMARY OF DATA & CONCLUSIONS

Based on the results of our field exploration and engineering analysis of the data obtained, we offer the following comments with regard to the infiltration of stormwater at the project site.

- The infiltration tests were conducted within the well graded, non-plastic, naturally-occurring soils of Stratum I and Stratum II.
- Groundwater was encountered within test pits TP-7, TP-8, TP-12 and TP-13 at depths ranging from approximately 1.5 to 6 feet below existing site grades.
- Soil mottling was encountered within test pits TP-12 and IT-13, starting at depths of approximately 2.5 feet below existing site grades and extending to 6 feet below existing site grades.

- The bedrock surface was encountered within test pits TP-10 and TP-11 at depths of approximately 7.5 and 9.5 feet below existing site grades, respectively

- Infiltration rates were found to range from no movement (0.0 inches per hour) to 12.0 inches per hour. These rates are unfactored. The PADEP recommended rate for infiltration of stormwater is 0.1 to 10 inches per hour.

LIMITATIONS

The conclusions contained in this report are based upon the subsurface data collected and on details stated in this report. Should conditions arise which differ from those specifically stated herein, our office should be notified immediately, so that our recommendations can be reviewed and revised, if necessary.

The conclusions presented herein should be applied only to the infiltration tests as depicted on the *Exploration Plan* for the proposed stormwater management facilities to be constructed for Westtown School in Westtown Township, Chester County, Pennsylvania. Advantage takes no responsibility in utilizing this information for any other purposes.

The scope of work was limited to the exploration of the subsurface subsoils. Oil, hazardous waste, radioactivity, irritants, pollutants, radon or other dangerous substances and conditions were not the subject of this study. Their presence and/or absence are not implied, inferred or suggested by this report or results of this study.

We trust that this is the information you require. Should you have any questions or if we may be of further assistance, please don't hesitate to contact our office.

Respectfully,
advantage engineers

Bailey Jean Wildasin

Bailey J. Wildasin
Geotechnical Specialist I

David J. Buckwalter
Senior Project Manager

APPENDIX

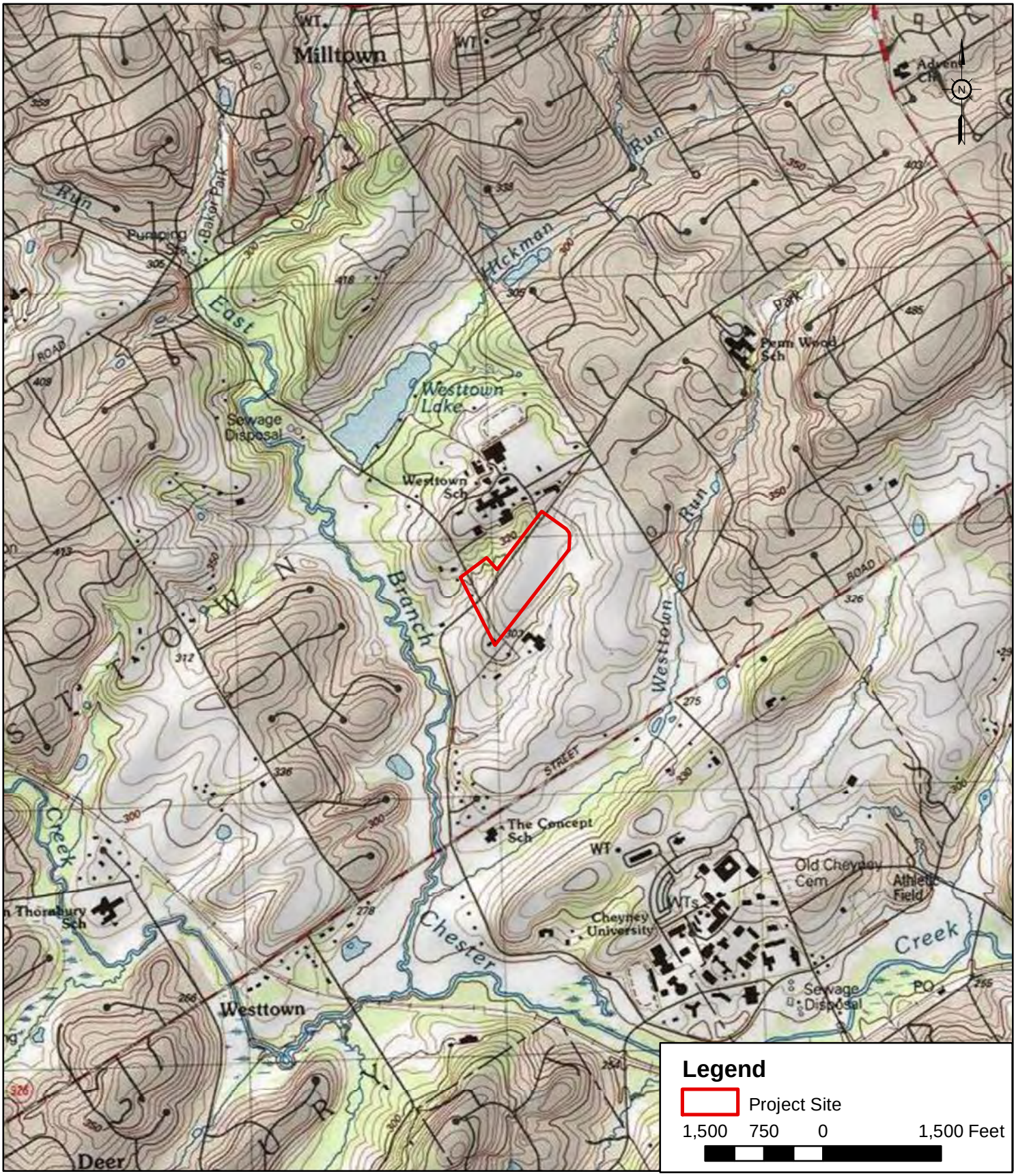
FIGURE 1 – TOPOGRAPHIC MAP

FIGURE 2 – GEOLOGIC MAP

FIGURE 3 – EXPLORATION PLAN

LABORATORY TEST RESULTS

TEST PIT LOGS



Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

SCALE: AS SHOWN	DRAWING NUMBER: FIGURE 1
DRAWN BY: B. WILDASIN	CHECKED BY: D. BUCKWALTER
APPROVED BY: M. GIUNTA	DATE: 9-10-2018

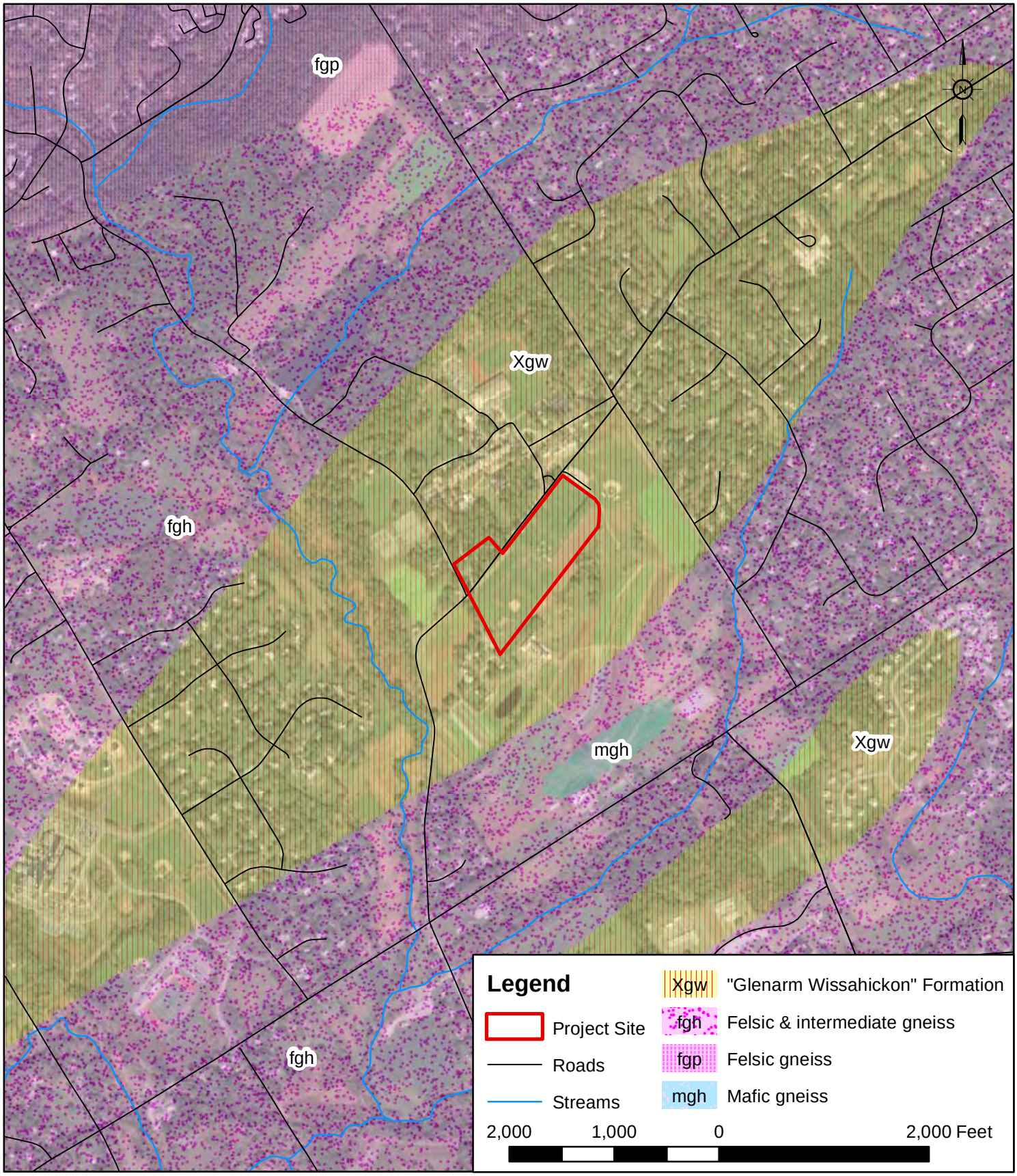
TOPOGRAPHIC MAP

PREPARED FOR

WESTTOWN SCHOOL OAK LANE - INFILTRATION

WESTTOWN TOWNSHIP CHESTER COUNTY PENNSYLVANIA

advantage engineers
435 INDEPENDENCE AVE., SUITE C
MECHANICSBURG, PA 17055
PH (717) 458-0800
FAX (717)458-0801



*Source - Map 61 - Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania, 1981, Pa Geological Survey

SCALE: AS SHOWN	DRAWING NUMBER: FIGURE 2
DRAWN BY: B. WILDASIN	CHECKED BY: D. BUCKWALTER
APPROVED BY: M. GIUNTA	DATE: 9-10-2018

GEOLOGIC MAP

PREPARED FOR

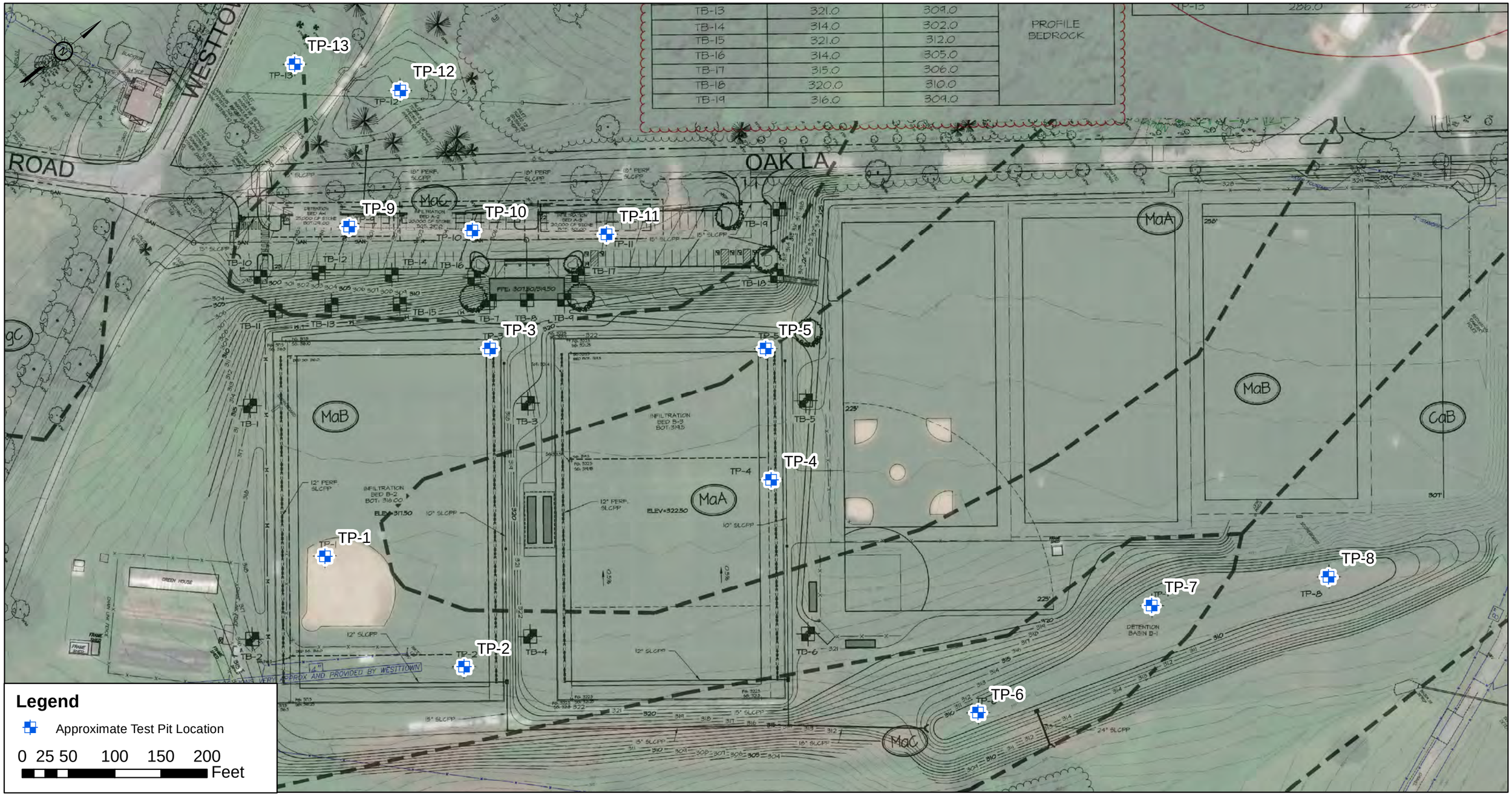
WESTTOWN SCHOOL OAK LANE - INFILTRATION

WESTTOWN TOWNSHIP CHESTER COUNTY PENNSYLVANIA

advantage engineers
435 INDEPENDENCE AVE., SUITE C
MECHANICSBURG, PA 17055
PH (717) 458-0800
FAX (717)458-0801

TB-13	321.0	309.0
TB-14	314.0	302.0
TB-15	321.0	312.0
TB-16	314.0	305.0
TB-17	315.0	306.0
TB-18	320.0	310.0
TB-19	316.0	309.0

PROFILE
BEDROCK



Legend

Approximate Test Pit Location

0 25 50 100 150 200 Feet

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

SCALE: AS SHOWN	DRAWING NUMBER: FIGURE 3
DRAWN BY: B. WILDASIN	CHECKED BY: D. BUCKWALTER
APPROVED BY: M. GIUNTA	DATE: 9-10-2018

BASE PLAN: Sketch Plan

PROVIDED BY: Site Engineering Concepts, LLC

DATE: 7-24-2017

EXPLORATION PLAN

PREPARED FOR

WESTTOWN SCHOOL OAK LANE - INFILTRATION

WESTTOWN TOWNSHIP CHESTER COUNTY PENNSYLVANIA

advantage engineers
435 INDEPENDENCE AVE., SUITE C
MECHANICSBURG, PA 17055
PH (717) 458-0800
FAX (717) 458-0801

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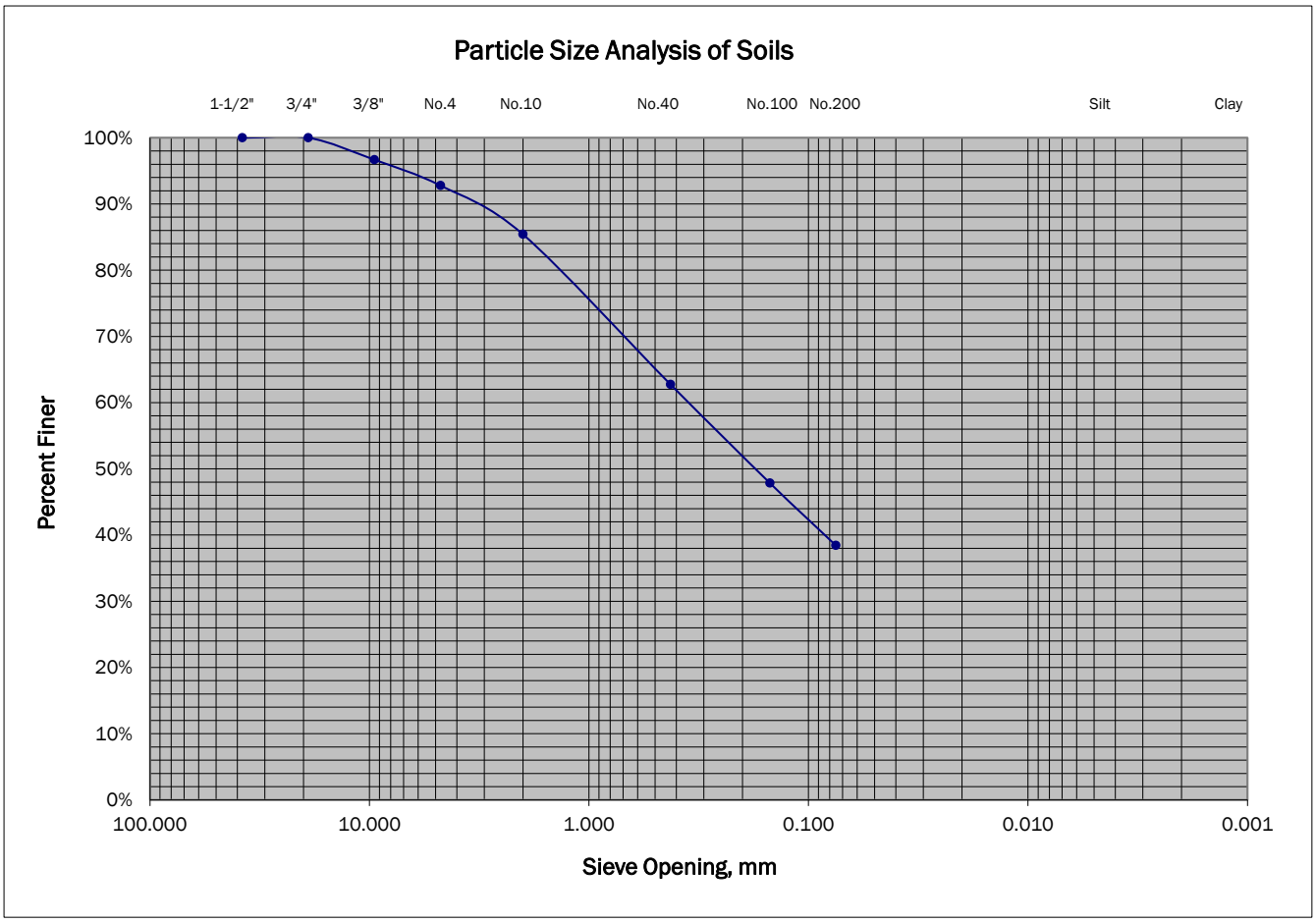
Soil Classification Report

Per ASTM Designations D 2487 and D 2488



As-Received Moisture 21.9%

USCS Classification: Silty SAND (SM)

Gravel:	7.2%	**Coarse:**	0.0%			**Fine:**	7.2%
Sand:	54.4%	**Coarse:**	7.4%	**Medium:**	22.7%	**Fine:**	24.3%
Fines:	38.4%	**Silt:**			**Clay:**		

Gravel Description: Subangular to Subrounded

Sand Description: Subangular

Consistency: N/A **Dry Strength:** Low

Dilatancy: Rapid **Toughness:** Low

Structure: Homogeneous **Cementation:** N/A

Test Pit: TP-2

Sample: S1 **Depth:** 3'

Project: Westtown School Oak Lane - Infiltration

Client: ELA Group, Inc.

Advantage Project Number: 1800331001

Particle Size Distribution

US Standard Sieve Size		Opening (mm)	%Finer
GRAVEL Coarse	1-1/2"	38.0	100.0%
	3/4"	19.0	100.0%
Fine	3/8"	9.50	96.7%
	No. 4	4.75	92.8%
SAND Coarse	No. 10	2.00	85.4%
Medium	No. 40	0.425	62.7%
	No. 100	0.150	47.9%
Fine	No. 200	0.075	38.4%
Hydrometer Analysis	Silt Size	0.005	
	Clay Size	0.001	

D_{60}:	D_{30}:	D_{10}:	Cu:	Cc:

Atterberg Limits **LL:** 36 **PL:** 33 **PI:** 3

Description: Brown Silty SAND

Remarks: Stratum I

Report Date: October 4, 2018

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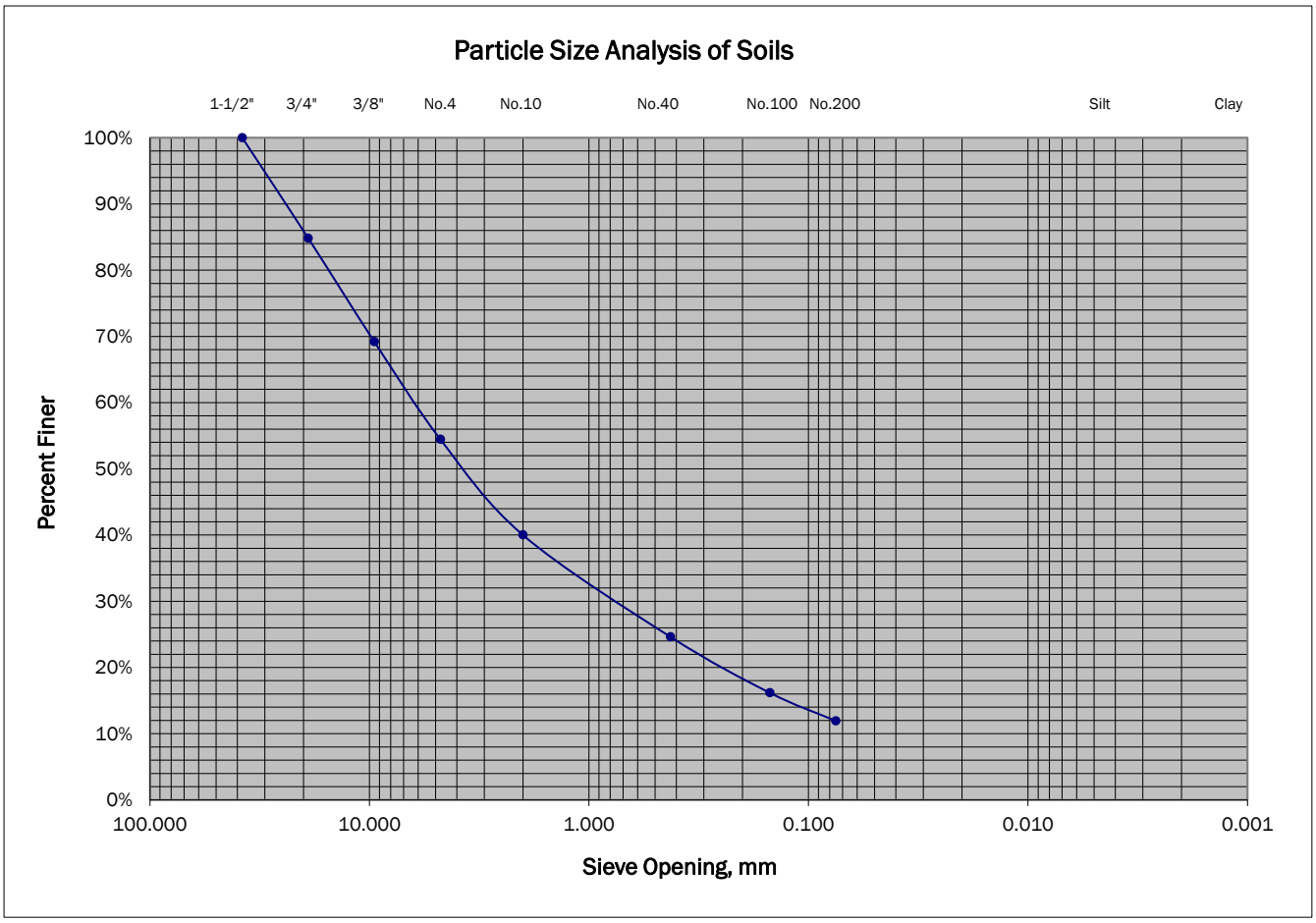
Soil Classification Report

Per ASTM Designations D 2487 and D 2488



As-Received Moisture 10.7%

USCS Classification: Poorly Graded GRAVEL with Silt and Sand (GP-GM)

Gravel: 45.6% **Coarse:** 15.2% **Fine:** 30.4%

Sand: 42.5% **Coarse:** 14.4% **Medium:** 15.4% **Fine:** 12.7%

Fines: 11.9% **Silt:** **Clay:**

Gravel Description: Subangular

Sand Description: Subangular

Consistency: N/A **Dry Strength:** Low

Dilatancy: Rapid **Toughness:** Low

Structure: Homogeneous **Cementation:** N/A

Test Pit: TP-5

Sample: S1 **Depth:** 4' - 6'

Project: Westtown School Oak Lane - Infiltration

Client: ELA Group, Inc.

Advantage Project Number: 1800331001

Particle Size Distribution

US Standard Sieve Size		Opening (mm)	%Finer
GRAVEL Coarse	1-1/2"	38.0	100.0%
	3/4"	19.0	84.8%
GRAVEL Fine	3/8"	9.50	69.2%
	No. 4	4.75	54.4%
SAND Coarse	No. 10	2.00	40.0%
SAND Medium	No. 40	0.425	24.6%
	No. 100	0.150	16.2%
SAND Fine	No. 200	0.075	11.9%
Hydrometer Analysis	Silt Size	0.005	
	Clay Size	0.001	

D_{60}: 6.3 D_{30}: 0.75 D_{10}: 0.57 Cu: 11 Cc: 0.16

Atterberg Limits **LL:** 36 **PL:** 35 **PI:** 1

Description: Brown GRAVEL with Silt and Sand

Remarks: Stratum I

Report Date: October 4, 2018

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TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-1

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±319.5'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.5' Tan Clayey SAND	**Baseball Infield**
	0.5' - 7.5' Brown Silty SAND	
5	Brown Silty SAND with Gravel	**Stratum I**
	-End of Test Pit at 7.5 Feet-	
10	Infiltration Tests Conducted at 3.5 Feet (316') and 5.5 Feet (314')	
15		

DOUBLE RING INFILTROMETER DATA

Test Depth:	3.5'		5.5'	
	Time (min)	Drop (inches')	Time (min)	Drop (inches)
Pre-soak 1	30	1.7	30	5.0
Pre-soak 2	30	1.2	30	5.0
Reading 1	30	1.0	10	1.0
Reading 2	30	0.8	10	1.0
Reading 3	30	0.8	10	1.0
Reading 4	30	1.0	10	1.0
Reading 5			10	1.0
Reading 6			10	1.0
Reading 7				
Reading 8				
Average Rate (inches per hour)		1.8		6.0

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Office: (717) 458-0800 Fax: (717) 458-0801
www.advantageengineers.com

EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 27, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-2

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±317'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.8' Brown organic soil	**Topsoil**
	0.8' - 5.0' Brown Sandy SILT	
	Brown Silty SAND	
5		**Stratum I**

-End of Test Pit at 5 Feet-

Infiltration Tests Conducted at 1 Foot (316') and 3 Feet (314')

DOUBLE RING INFILTROMETER DATA			
Test Depth:		1'	3'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	no movement	1
Pre-soak 2	30	no movement	0.7
Reading 1	30	no movement	0.8
Reading 2	30	no movement	0.8
Reading 3	30	no movement	0.6
Reading 4	30	no movement	0.6
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		0.0 (no movement)	1.4

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 27, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-3

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±321'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.8' Brown organic soil	**Topsoil**
	0.8' - 7.5' Brown Silty SAND	
5	Brown Silty SAND with Gravel	**Stratum I**
10	**-End of Test Pit at 7.5 Feet-**	
15	Infiltration Tests Conducted at 3.5 Feet (317.5') and 5.5 Feet (315.5')	
20		
25		
30		

DOUBLE RING INFILTROMETER DATA

Test Depth:		3.5'	5.5'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	3.7	5.0
Pre-soak 2	30	3.6	5.0
Reading 1	10	1.2	3.2
Reading 2	10	0.9	1.9
Reading 3	10	0.9	2.0
Reading 4	10	1.1	2.1
Reading 5	10	1.0	1.9
Reading 6	10	1.0	2.0
Reading 7			
Reading 8			
Average Rate (inches per hour)		6.0	12.0

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 27, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-4

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±319.5'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.8' Brown organic soil	**Topsoil**
	0.8' - 4.5' Brown Sandy SILT	
5		**Stratum I**
	-End of Test Pit at 4.5 Feet-	
10		
15		
20		
25		
30		

Infiltration Tests Conducted at 1 Foot (318.5') and 2.5 Feet (317')

DOUBLE RING INFILTROMETER DATA			
Test Depth:		1'	2.5'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	0.6	0.7
Pre-soak 2	30	0.6	0.6
Reading 1	30	0.6	0.6
Reading 2	30	0.6	0.5
Reading 3	30	0.6	0.5
Reading 4	30	0.6	0.5
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		1.2	1.0

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 26, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-5

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±321'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.8' Dark brown Sandy CLAY with organic debris	**Topsoil**
	0.8' - 6.0' Brown Silty SAND	
	Brown GRAVEL with Silt and Sand	
5		
		Stratum I
	-End of Test Pit at 6 Feet-	
	Infiltration Tests Conducted at 1.5 Feet (319.5') and 4 Feet (317')	
10		
15		

DOUBLE RING INFILTROMETER DATA

Test Depth:	1.5'		4'	
	Time (min)	Drop (inches)	Time (min)	Drop (inches)
Pre-soak 1	30	2.4	30	3.4
Pre-soak 2	30	1.8	30	3.5
Reading 1	30	1.8	10	1.0
Reading 2	30	1.7	10	0.8
Reading 3	30	1.7	10	0.8
Reading 4	30	1.7	10	0.8
Reading 5			10	0.8
Reading 6				
Reading 7				
Reading 8				
Average Rate (inches per hour)		3.4		4.8

20 25 30

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 26, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-6

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±311'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.5' Dark brown organic soil	**Tilled Soil**
	1.5' - 6.0' Brown Sandy SILT	**Stratum I**
5		
10	**-End of Test Pit at 6 Feet-**	
15	Infiltration Tests Conducted at 2 Feet (309') and 4 Feet (307')	
20		
25		
30		

DOUBLE RING INFILTROMETER DATA

Test Depth:		2'	4'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	0.6	no movement
Pre-soak 2	30	0.4	no movement
Reading 1	30	0.5	no movement
Reading 2	30	0.5	no movement
Reading 3	30	0.5	no movement
Reading 4	30	0.5	no movement
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		1.0	0.0 (no movement)

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 26, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-7

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±313'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Wet

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: 6' Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.3' Brown organic soil	**Tilled Soil**
	1.3' - 8.0' Brown Sandy SILT Brown Silty SAND	
5		H_2O @ 6'
		Stratum I
	-End of Test Pit at 8 Feet-	
10		
	Infiltration Tests Conducted at 2 Feet (311') and 4 Feet (309')	
15		
20		
25		
30		

DOUBLE RING INFILTROMETER DATA

Test Depth:		2'	4'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	0.1	2.7
Pre-soak 2	30	no movement	1.7
Reading 1	30	no movement	1.5
Reading 2	30	no movement	1.5
Reading 3	30	no movement	1.4
Reading 4	30	no movement	1.4
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		0.0 (no movement)	2.8

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 26, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-8

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±311'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Wet

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: 1.5' Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.5' Brown organic soil	**Tilled Soil**
	1.5' - 6.0' Brown Silty SAND	**H_2O @ 1.5'**
5		**Stratum I**
	-End of Test Pit at 6 Feet-	
	No infiltration tests conducted due to groundwater at 1.5 Feet (309.5')	
10		
15		
20		
25		
30		

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 26, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-9

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±303'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION		REMARKS
	0.0' - 0.9'	Brown organic soil	**Topsoil**
	0.9' - 10.0'	Brown Silty SAND	
5		Brown Silty SAND with Gravel	
10			**Stratum I**

-Extent of Equiptment at 10 Feet-
-End of Test Pit at 10 Feet-

Infiltration Tests Conducted at 8 Feet (295')

DOUBLE RING INFILTROMETER DATA			
Test Depth:		8'	8'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	4.0	4.0
Pre-soak 2	30	2.3	2.5
Reading 1	10	0.7	0.7
Reading 2	10	0.7	0.7
Reading 3	10	0.6	0.7
Reading 4	10	0.6	0.6
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		3.9	4.0

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 28, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-10

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±305'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.9' Brown organic soil	**Topsoil**
	0.9' - 6.0' Brown Silty SAND	
5		**Stratum I**
	6.0' - 7.5' Brown Silty SAND with Gravel (highly weathered rock)	**Stratum II**
10	**-Bucket Refusal at 7.5 Feet-** **-End of Test Pit at 7.5 Feet-**	
	Infiltration Tests Conducted at 4 Feet (301') and 5.5 Feet (299.5')	
15		

DOUBLE RING INFILTROMETER DATA

Test Depth:	4'		5.5'	
	Time (min)	Drop (inches)	Time (min)	Drop (inches)
Pre-soak 1	30	2.2	30	3.5
Pre-soak 2	30	1.5	30	2.7
Reading 1	30	1.4	10	0.9
Reading 2	30	1.4	10	0.6
Reading 3	30	1.4	10	0.8
Reading 4	30	1.4	10	0.8
Reading 5			10	0.8
Reading 6			10	0.8
Reading 7				
Reading 8				
Average Rate (inches per hour)		2.8		4.8

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 28, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-11

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±309'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 0.8' Brown organic soil	**Topsoil**
	0.8' - 6.0' Brown Silty SAND	
5		**Stratum I**
	6.0' - 9.5' Brown Silty SAND with Gravel (highly weathered rock)	
10		**Stratum II**

-Bucket Refusal at 9.5 Feet-
-End of Test Pit at 9.5 Feet-

Infiltration Tests Conducted at 6 Feet (303') and 7.5 Feet (301.5')

DOUBLE RING INFILTROMETER DATA			
Test Depth:		6'	7.5'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	4.0	3.5
Pre-soak 2	30	4.0	3.0
Reading 1	10	1.2	0.9
Reading 2	10	1.0	0.8
Reading 3	10	1.0	0.9
Reading 4	10	1.0	0.9
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		6.0	5.4

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 27, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-12

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±298'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Wet

☐ FIELD SURVEYED ☒ TOPO ESTIMATE

DEPTH: 3.5' Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 2.3' Brown organic soil	**Topsoil**
	2.3' - 6.0' Brown to gray Sandy CLAY	**H_2O @ 3.5'**
5	(Soil Mottling 2.5' - 6.0')	**Stratum III**
	-End of Test Pit at 6 Feet-	
10	No infiltration tests conducted due to Soil Mottling at 2.5 Feet (295.5') and Groundwater at 3.5 Feet (294.5')	
15		
20		
25		
30		

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EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 28, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Infiltration

TEST PIT NO.: TP-13

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±286'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Wet

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: 1.5' Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.5' Brown organic soil	**Topsoil**
	1.5' - 6.0' Brown to gray Sandy CLAY (Soil Mottling 2.5' - 6.0')	**H_2O @ 1.5'**
5		**Stratum III**
	-End of Test Pit at 6 Feet-	
10	No infiltration tests conducted due to Groundwater at 1.5 Feet (284.5') and Soil Mottling at 2.5 Feet (283.5')	
15		
20		
25		
30		

advantage engineers

435 Independence Avenue, Suite C, Mechanicsburg, PA 17055
Office: (717) 458-0800 Fax: (717) 458-0801
www.advantageengineers.com

EXCAVATION METHOD: Mini-excavator

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: September 28, 2018

DRAWN/COMPILED BY: B. Wildasin

November 9, 2018

Westtown School
975 Westtown Road
West Chester, PA 19382

c/o

Mr. Charles R. Haley, Jr., P.E.
ELA Group, Inc.
743 South Broad Street
Lititz, PA 17543

RE: Supplemental Infiltration Feasibility Report
Westtown School Oak Lane – Supplemental Infiltration
Westtown Township, Chester County, Pennsylvania
Advantage Project Number: 1800331001

Dear Mr. Haley:

In accordance with your request, Advantage Engineers (Advantage) has completed supplemental infiltration testing for the above referenced project site. This correspondence serves to transmit the results of our supplemental evaluation.

SCOPE OF WORK

The objective of our work was to determine the permeability of the invert soils, identify any limiting zones (i.e. bedrock, groundwater, or seasonal high water table) within the proposed stormwater management facility, and address PADEP requirements as they relate to stormwater management. Our scope of work included the completion of a subsurface exploration and preparation of this report. This report presents a summary of the scope of work completed, conditions encountered, and results of the supplemental infiltration testing engineering analysis of subsurface conditions.

SUBSURFACE FIELD EXPLORATION

In order to characterize subsurface conditions, 3 test pits were excavated on October 31, 2018. Supervision and monitoring of the field exploration was provided by a representative of Advantage who field located the test locations based on the "Updated Sketch Plan", prepared by Site Engineering Concepts, LLC. The approximate test locations, referenced as TP-14 through TP-16, are shown on the attached *Exploration Plan* (Figure 1). Data pertaining to the subsurface exploration was documented in the field and is presented in detail on the *Test Pit Logs*, which contain detailed descriptions of the subsurface materials encountered and infiltration test depths/elevations. A general description of the soil conditions encountered is provided in the "Subsurface Conditions" section of this report.

SUBSURFACE CONDITIONS

Soil

Surficial Materials

Each test pit was covered by approximately 16 inches of tilled soil; however, the thickness of surficial materials may differ in unexplored areas of the project site.

Stratum I – Brown Silty SAND/Sandy SILT

Stratum I was encountered within test pits TP-14 and TP-16 and extended to depths of approximately 5 feet below existing site grades. Upon review, the soils of Stratum I were found to be moderately well graded, non-plastic and comprised of Silty SAND and Sandy SILT.

Stratum II – Brown Silty SAND with Gravel (highly weathered rock)

Stratum II was only encountered within test pit TP-16 and extended to its termination depth of approximately 7 feet below existing site grades. Upon review, the soils of Stratum II were found to be well graded, non-plastic and predominately comprised of Silty SAND with Gravel. The soils of Stratum II represent the highly weathered bedrock surface.

Stratum III – Brown Sandy CLAY

Stratum III was only encountered within test pit TP-15 and extended to its termination depth of approximately 5 feet below existing site grades. Upon review, the soils of Stratum III were found to be poorly graded, plastic and comprised of Sandy CLAY.

Bedrock

The bedrock surface was not encountered within the test pits excavated. The bedrock surface would have been defined as the depth at which the bucket of the given excavation equipment could no longer excavate.

Groundwater/Soil Mottling

Neither groundwater nor soil mottling was encountered within the test pits excavated. These observations were made at the time of the field operation and groundwater table elevations will vary with daily, seasonal, and climatological variations.

INFILTRATION ANALYSIS

To evaluate the feasibility of stormwater infiltration within the proposed stormwater management facility, infiltration tests were completed utilizing the "double-ring" infiltrometer method in accordance with the Pennsylvania Stormwater Best Management Practices Manual, latest Edition. It should be noted that the shallow tests in both TP-14 and TP-15 were completed 6-inches below the proposed test elevations due to the thickness of the tilled soil. The test pit locations, approximate surface elevations, proposed test elevations, actual test elevations, presence of limiting zones, and the infiltration rates achieved at each location are presented in the table below.

INFILTRATION TEST RESULTS					
Test Location	**Surface Elevation (ft)**	**Proposed Test Elevations (ft)**	**Actual Test Elevations (FT)**	**Limiting Zone Elevation (ft)**	**Infiltration Rate* (in/hr)**
TP-14	290	289	288.5	Not Encountered @ 285	0.2
		287	287		1.0
TP-15	290	289	288.5	Not Encountered @ 285	0.0
		287	287		0.0
TP-16	292	289	289	Not Encountered @ 285	2.7
		287	287		6.0

**Infiltration rates represent the rates recorded in the field and no safety factor has been applied*

SUMMARY OF DATA & CONCLUSIONS

Based on the results of our field exploration and engineering analysis of the data obtained, we offer the following comments with regard to the infiltration of stormwater at the project site.

- The infiltration tests were conducted within the naturally-occurring soils of Stratum I, Stratum II and Stratum III.
- No limiting zones (i.e. bedrock, groundwater and/or soil mottling) were encountered within the test pits excavated.
- The unfactored infiltration rates were found to range from no movement (0.0 inches per hour) to 6.0 inches per hour. The PADEP recommended rate for infiltration of stormwater is 0.1 to 10 inches per hour.

LIMITATIONS

The conclusions contained in this report are based upon the subsurface data collected and on details stated in this report. Should conditions arise which differ from those specifically stated herein, our office should be notified immediately, so that our recommendations can be reviewed and revised, if necessary.

The conclusions presented herein should be applied only to the infiltration tests as depicted on the *Exploration Plan* for the proposed Westtown School improvements in Westtown Township, Chester County, Pennsylvania. Advantage takes no responsibility in utilizing this information for any other purposes.

The scope of work was limited to the exploration of the subsurface subsoils. Oil, hazardous waste, radioactivity, irritants, pollutants, radon or other dangerous substances and conditions were not the subject of this study. Their presence and/or absence are not implied, inferred or suggested by this report or results of this study.

We trust that this is the information you require. Should you have any questions or if we may be of further assistance, please don't hesitate to contact our office.

Respectfully,
advantage engineers

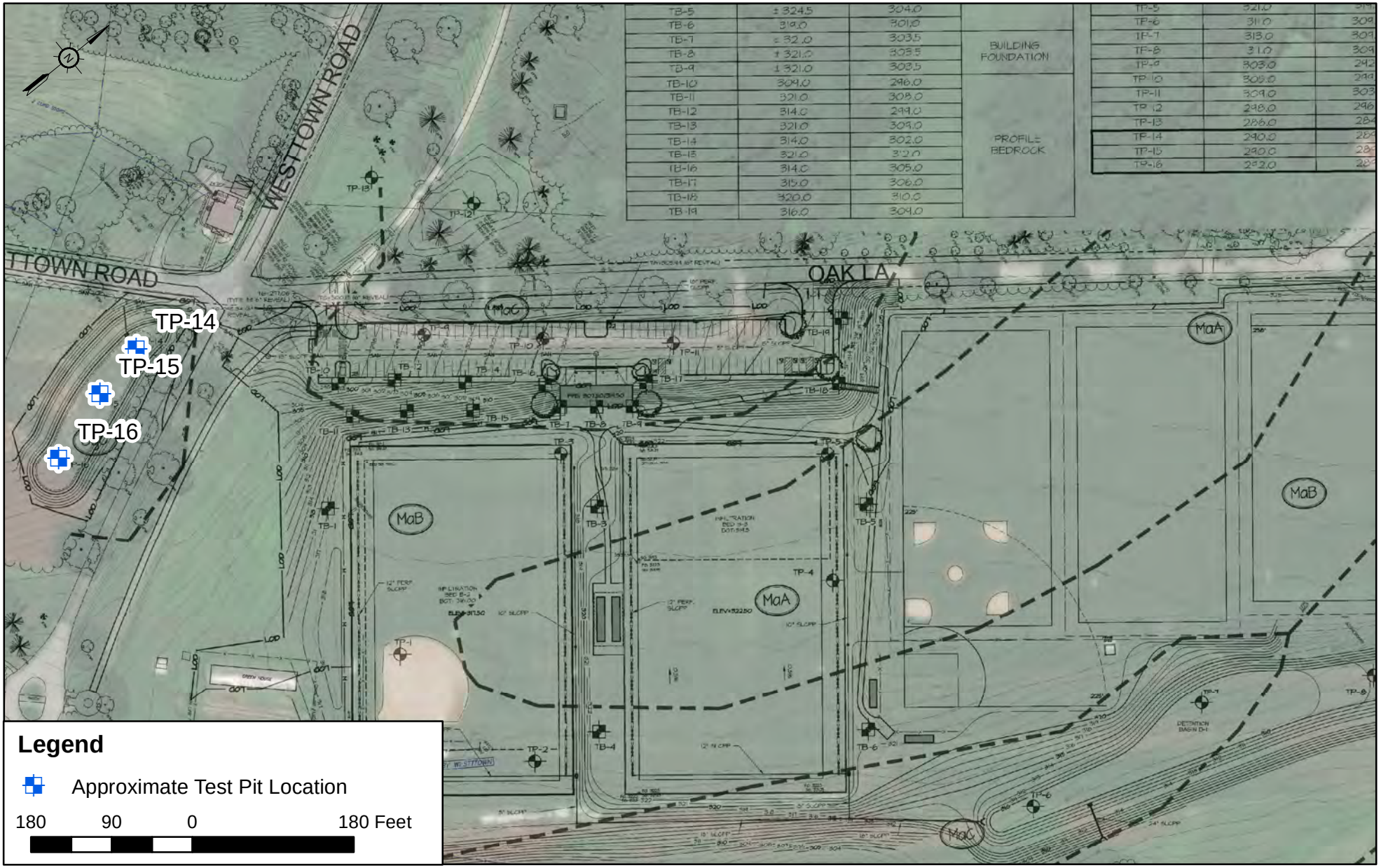
Bailey Jean Wildasin

Bailey J. Wildasin
Geotechnical Specialist I

David J. Buckwalter
Senior Project Manager

Attachments:

Exploration Plan – Figure 1
Test Pit Logs



*Source - "Updated Sketch Plan" provided by Site Engineering Concepts, LLC, received 10-24-2018

SCALE: AS SHOWN	DRAWING NUMBER: FIGURE 1
DRAWN BY: B. WILDASIN	CHECKED BY: D. BUCKWALTER
APPROVED BY: M. GIUNTA	DATE: 10-26-2018

EXPLORATION PLAN

PREPARED FOR

WESTTOWN SCHOOL OAK LANE - SUPPLEMENTAL INFILTRATION

WESTTOWN TOWNSHIP CHESTER COUNTY PENNSYLVANIA

advantage engineers
435 INDEPENDENCE AVE., SUITE C
MECHANICSBURG, PA 17055
PH (717) 458-0800
FAX (717)458-0801

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Supplemental Infiltration

TEST PIT NO.: TP-14

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±290'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.3' Brown organic soil	**Tilled Soil**
	1.3' - 5.0' Brown Sandy SILT Brown Silty SAND	
5		**Stratum I**
	-End of Test Pit at 5 Feet-	
10		
	Infiltration Tests Conducted at 1.5 Feet (288.5') and 3 Feet (287')	
15		
20		
25		
30		

DOUBLE RING INFILTROMETER DATA			
Test Depth:		1.5'	3'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	0.3	0.8
Pre-soak 2	30	0.2	0.7
Reading 1	30	0.1	0.5
Reading 2	30	0.1	0.5
Reading 3	30	0.1	0.5
Reading 4	30	0.1	0.5
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		0.2	1.0

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EXCAVATION METHOD: Backhoe

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: October 31, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Supplemental Infiltration

TEST PIT NO.: TP-15

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±290'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.3' Brown organic soil	**Tilled Soil**
	1.3' - 5.0' Brown Sandy CLAY	
5		**Stratum III**
	-End of Test Pit at 5 Feet-	
10		
15		
20		
25		
30		

Infiltration Tests Conducted at 1.5 Feet (288.5') and 3 Feet (287')

DOUBLE RING INFILTROMETER DATA			
Test Depth:		1.5'	3'
	Time (min)	Drop (inches)	Drop (inches)
Pre-soak 1	30	0.2	0.0
Pre-soak 2	30	0.0	0.0
Reading 1	30	0.0	0.0
Reading 2	30	0.0	0.0
Reading 3	30	0.0	0.0
Reading 4	30	0.0	0.0
Reading 5			
Reading 6			
Reading 7			
Reading 8			
Average Rate (inches per hour)		0.0 (no movement)	0.0 (no movement)

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EXCAVATION METHOD: Backhoe

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: October 31, 2018

DRAWN/COMPILED BY: B. Wildasin

TEST PIT LOG

PROJECT NAME: Westtown School Oak Lane - Supplemental Infiltration

TEST PIT NO.: TP-16

PROJECT NO.: 1800331001 CLIENT: ELA Group, Inc.

TOP OF GROUND: ±292'

LOCATION: See Exploration Plan (Figure 3)

GROUNDWATER DATA: Dry

[ ] FIELD SURVEYED [X] TOPO ESTIMATE

DEPTH: Not Encountered Time: Completion

DEPTH (feet)	SOIL DESCRIPTION	REMARKS
	0.0' - 1.3' Brown organic soil	**Tilled Soil**
5	1.3' - 5.0' Brown Silty SAND	**Stratum I**
	5.0' - 7.0' Brown Silty SAND with Gravel (highly weathered rock)	**Stratum II**
10	**-End of Test Pit at 7 Feet-**	
	Infiltration Tests Conducted at 3 Feet (289') and 5 Feet (287')	
15		

DOUBLE RING INFILTROMETER DATA

Test Depth:	3'		5'	
	Time (min)	Drop (inches)	Time (min)	Drop (inches)
Pre-soak 1	30	1.9	30	5.0
Pre-soak 2	30	1.4	30	5.0
Reading 1	30	1.4	10	1.0
Reading 2	30	1.3	10	1.0
Reading 3	30	1.3	10	1.0
Reading 4	30	1.4	10	1.0
Reading 5			10	1.0
Reading 6				
Reading 7				
Reading 8				
Average Rate (inches per hour)		2.7		6.0

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EXCAVATION METHOD: Backhoe

ADVANTAGE REPRESENTATIVE: B. Wildasin

DATE EXCAVATED: October 31, 2018

DRAWN/COMPILED BY: B. Wildasin